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A Continuing  
Bibliography  
with Indexes

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# **ENERGY**

## **A Continuing Bibliography**

### **With Indexes**

### **Issue 22**

A selection of annotated references to unclassified reports and journal articles that were introduced into the NASA scientific and technical information system and announced from April 1 through June 30, 1979 in

- *Scientific and Technical Aerospace Reports (STAR)*
- *International Aerospace Abstracts (IAA).*



Scientific and Technical Information Branch

**National Aeronautics and Space Administration**

Washington, DC

**1979**

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# INTRODUCTION

This issue of *Energy: A Continuing Bibliography with Indexes* (NASA SP-7043(22)) lists 1096 reports, journal articles, and other documents announced between April 1, 1979 and June 30, 1979 in *Scientific and Technical Aerospace Reports (STAR)* or in *International Aerospace Abstracts (IAA)*. The first issue of this continuing bibliography was published in May 1974 and succeeding issues are published quarterly.

The coverage includes regional, national and international energy systems; research and development on fuels and other sources of energy; energy conversion, transport, transmission, distribution and storage, with special emphasis on use of hydrogen and of solar energy. Also included are methods of locating or using new energy resources. Of special interest is energy for heating, lighting, for powering aircraft, surface vehicles, or other machinery.

Each entry in the bibliography consists of a standard bibliographic citation accompanied in most cases by an abstract. The listing of the entries is arranged in two major sections, *IAA Entries* and *STAR Entries* in that order. The citation, and abstracts when available, are reproduced exactly as they appeared originally in *IAA* or *STAR* including the original accession numbers from the respective announcement journals. This procedure, which saves time and money accounts for the slight variation in citation appearances.

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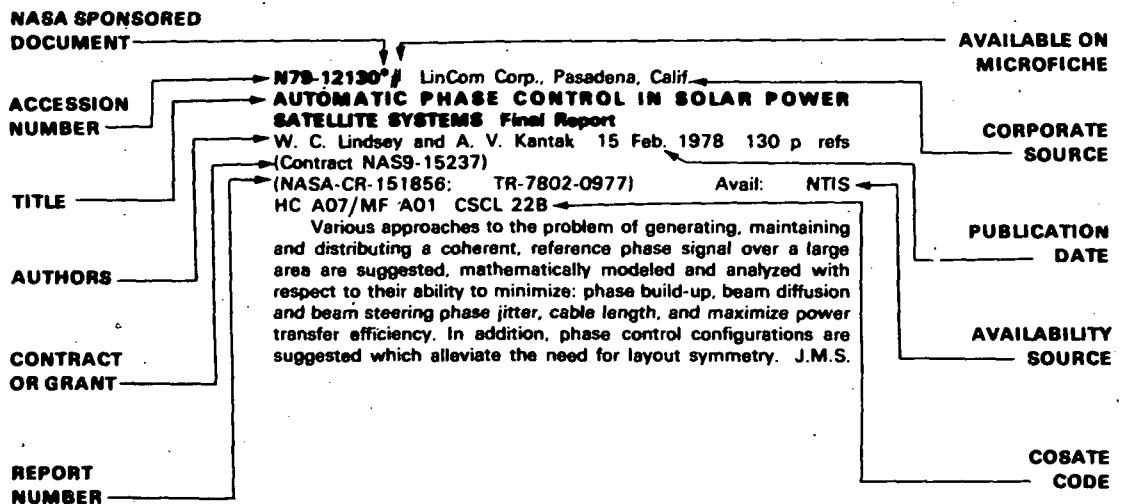
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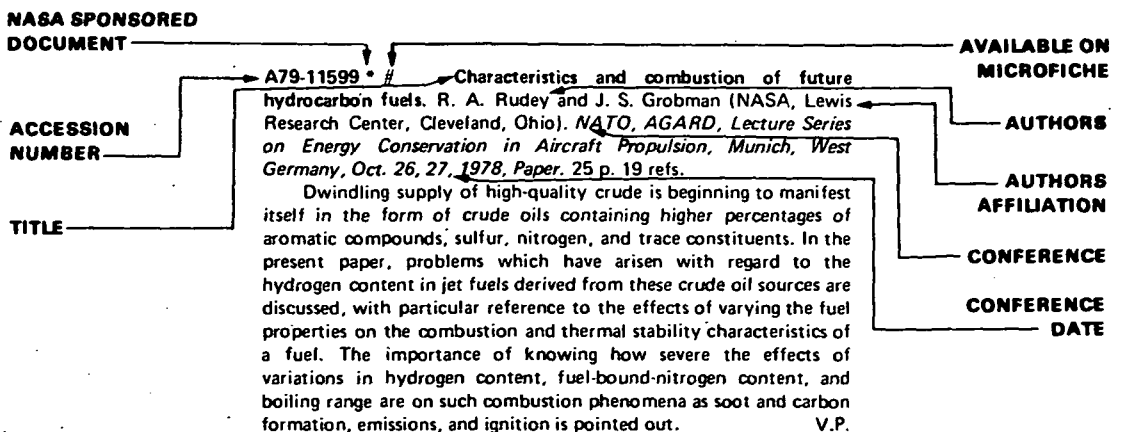
# TABLE OF CONTENTS

IAA Entries .....	235
STAR Entries .....	329
Subject Index .....	A-1
Personal Author Index .....	B-1
Corporate Source Index .....	C-1
Contract Number Index .....	D-1
Report/Accession Number Index .....	E-1

## TYPICAL CITATION AND ABSTRACT FROM STAR



## TYPICAL CITATION AND ABSTRACT FROM IAA



## **A Listing of Energy Bibliographies Contained In This Publication:**

1. Cryogenic refrigeration, volume 2. A bibliography with abstracts p0331 N79-16144
2. Cryogenic refrigeration, volume 3. A bibliography with abstracts p0331 N79-16145
3. Oil pollution reports, volume 5, number 2 --- bibliographies p0336 N79-16437
4. Solar water pumps. Citations from the Engineering Index data base p0343 N79-17348
5. Optical coatings for solar cells and solar collectors. Citations from the NTIS data base p0350 N79-18465
6. Optical coatings for solar cells and solar collectors. Citations from the Engineering index data base p0350 N79-18466
7. Synthetic fuels: Methane. Citations from the Engineering Index data base p0365 N79-21223

JULY 1979

### IAA ENTRIES

**A79-20511** On vibration of a thick flexible ring rotating at high speed. C. W. Bert and T. L. C. Chen (Oklahoma, University, Norman, Okla.). (U.S. National Congress of Applied Mechanics, 8th, University of California, Los Angeles, Calif., June 26-30, 1978.) *Journal of Sound and Vibration*, vol. 61, Dec. 22, 1978, p. 517-530. 23 refs. Research supported by the U.S. Department of Energy.

In connection with high-performance flywheel energy storage systems containing a thick ring as the primary storage element, there is considerable current interest in the vibrational modes of such an element. In the present analysis both in-plane bending and coupled twisting/out-of-plane bending modes are considered. It is believed to be the first to include either transverse shear deformation or support restraint in the vibrational analysis of rotating rings. Numerical results are presented for a specific flywheel system currently under development. (Author)

**A79-20526** Applied Superconductivity Conference, Pittsburgh, Pa., September 25-28, 1978, Proceedings. Conference sponsored by APS, IEEE, DOE, NBS, et al. Edited by S. J. Saint Laurant (Stanford University, Stanford, Calif.). *IEEE Transactions on Magnetism*, vol. MAG-15, Jan. 1979. 920 p.

Advances in technology and theory of magnets and magnetic components for a wide range of superconductivity applications are reported. The main areas studied include RF cavities and resonators; magnet stability; multifilament Nb<sub>3</sub>Sn composites; accelerator applications, magnets, and systems; superconducting power transmission and switching; practical multifilament Nb<sub>3</sub>Sn composites; conductor losses; submicrowatt devices; MHD and energy storage magnets; conductor stability; multifilament V<sub>3</sub>Ga, NbTi, and Nb<sub>3</sub>Sn; new materials such as Nb<sub>3</sub>Si and Nb<sub>3</sub>Ge; high-energy physics applications; superconducting machinery; large-scale conductors; utility applications; and fusion magnets and quench protection. P.T.H.

**A79-20530** Electric power losses of current input into superconducting devices cooled by supercritical helium. V. I. Maksimov and A. I. Malykhin (Gosudarstvennyi Nauchno-Issledovatel'skii Energeticheskii Institut, Moscow, USSR). (Applied Superconductivity Conference, Pittsburgh, Pa., Sept. 25-28, 1978.) *IEEE Transactions on Magnetism*, vol. MAG-15, Jan. 1979, p. 165-168. 8 refs.

This paper deals with the methods and results of calculations to minimize power losses in cryogenic installations related to current input into superconducting systems with forced supercritical helium cooling. Different schemes and modes of cooling the current leads with a superconducting region at the cold end are examined. Optimum helium flow rate and minimum power losses in an idealized and an actual cryogenic unit are defined. The calculations were made within the working temperature range of 5-18 K. The paper shows that the choice of the current lead cooling scheme allowing for minimum power losses depends on the relation between the temperatures of the superconducting device and of the superconducting transition in the superconducting region of the current lead. The value of minimum power losses decreases with the growth of the transient temperature in the superconducting region. (Author)

**A79-20531** Observation of voltage fluctuations in a Superconducting Magnet during MHD power generation. R. P. Smith, R. C. Niemann, M. R. Kraimer, and T. E. Zinnerman (Argonne National Laboratory, Argonne, Ill.). (Applied Superconductivity Conference, Pittsburgh, Pa., Sept. 25-28, 1978.) *IEEE Transactions on Magnetism*, vol. MAG-15, Jan. 1979, p. 295-297. 6 refs. Research supported by the U.S. Department of Energy.

Fluctuating voltage signals on the potential taps of the ANL 5.0 T MHD Superconducting Dipole Magnet have been observed during MHD power generation at the U-25B Facility at the High Temperature Institute (IVTAN) Moscow, USSR. Various other thermodynamic and electrical parameters of the U-25B flow train have been recorded, and statistical analysis concerning correlations between the phenomena with a view of discerning causal interdependence is in progress. Voltage fluctuations observed at the magnet terminals are analyzed with special emphasis on magnet stability. (Author)

**A79-20532** Design and operating experience of the cryogenic system of the U.S. SCMS as incorporated into the bypass loop of the U-25 MHD generator facility. R. C. Niemann, K. F. Mataya (Argonne National Laboratory, Argonne, Ill.), D. A. McWilliams, R. Borden, M. H. Streeter, R. Wickson (CTI-Cryogenics, Sudbury, Mass.), N. P. Privalov (Akademiia Nauk SSSR, Nauchno-Issledovatel'skii Institut Vysokikh Temperatur, Moscow, USSR), and P. Smelser. (Applied Superconductivity Conference, Pittsburgh, Pa., Sept. 25-28, 1978.) *IEEE Transactions on Magnetism*, vol. MAG-15, Jan. 1979, p. 298-301. 8 refs. Research supported by the U.S. Department of Energy.

**A79-20533** A superconducting dipole magnet for the UTSI MHD Facility. S.-T. Wang, R. C. Niemann, L. R. Turner, L. Genens, W. Pelczarski, J. Gonczy, J. Hoffman, Y.-C. Huang, N. Modjeski, and E. Kraft (Argonne National Laboratory, Argonne, Ill.). (Applied Superconductivity Conference, Pittsburgh, Pa., Sept. 25-28, 1978.) *IEEE Transactions on Magnetism*, vol. MAG-15, Jan. 1979, p. 302-305. Research supported by the U.S. Department of Energy.

The Argonne National Laboratory is designing and will build a large superconducting dipole magnet system for use in the Coal Fired Flow MHD Research Facility at the University of Tennessee Space Institute (UTSI). Presented in detail are the conceptual design of the magnet geometry, conductor design, cryostability evaluation, magnetic pressure computation, structural design, cryostat design, and the cryogenics system design. (Author)

**A79-20534** Fabrication and assembly considerations for a base load MHD superconducting magnet system. R. J. Thome, R. D. Pillsbury, J. W. Ayers, and T. M. Hrycaj (Magnetic Corporation of America, Waltham, Mass.). (Applied Superconductivity Conference, Pittsburgh, Pa., Sept. 25-28, 1978.) *IEEE Transactions on Magnetism*, vol. MAG-15, Jan. 1979, p. 306-309. Contract No. E(49-18)-2217.

**A79-20535** Practical aspects of designing and manufacturing MHD superconducting base-load magnets in 1988 time frame. S. L. Ackerman, C. E. Royce (General Dynamics Corp., Convair Div., San Diego, Calif.), R. N. Randall (Supercon, Inc., Natick, Mass.), and E. J. Rappaport (Magnetic Engineering Associates, Boston, Mass.). (Applied Superconductivity Conference, Pittsburgh, Pa., Sept. 25-28, 1978.) *IEEE Transactions on Magnetism*, vol. MAG-15, Jan. 1979, p. 310-313.

Manufacturing alternatives for three base-load MHD superconducting magnets are discussed. The three designs are two circular saddle concepts and a rectangular saddle concept. They are discussed with respect to insulation, substructure and superstructure, and final assembly operation. The circular design deals with force containment

in a more direct manner, utilizing the straight-line tensile paths of the shells and stave as opposed to the large moment generation inherent in the rectangular design. All three concepts use similar manufacturing methods, but circular designs minimize or simplify the respective manufacturing methods and result in better efficiency and lower cost. P.T.H.

**A79-20536** Design criteria for multilayer superconductive magnets. M. N. El Derini, M. A. Hilal, and R. W. Boom (Wisconsin, University, Madison, Wis.). (*Applied Superconductivity Conference, Pittsburgh, Pa., Sept. 25-28, 1978.*) *IEEE Transactions on Magnetism*, vol. MAG-15, Jan. 1979, p. 314-317. Research supported by the U.S. Department of Energy.

High current round composite conductors with superconductors near the surface are under development at the University of Wisconsin. The conductors are designed for single layer energy storage solenoids and possibly for solenoids with several layers. The radial and axial forces in such magnets are obtained by summing forces between turns. Solenoids with constant tension are achieved by changing the spacing between conductors in the axial direction. Multilayer solenoids are designed so that the tension in the different layers is the same as the required design value. This design value is chosen to make the conductors remain in tension. Constant tension designs facilitate the economic use of force-bearing structure in energy storage and fusion superconductive magnets. (Author)

**A79-20537** Superconducting energy storage magnets. M. Masuda, T. Shintomi, H. Sato, and A. Kabe (National Laboratory for High Energy Physics, Tsukuba, Ibaraki, Japan). (*Applied Superconductivity Conference, Pittsburgh, Pa., Sept. 25-28, 1978.*) *IEEE Transactions on Magnetism*, vol. MAG-15, Jan. 1979, p. 318-321. 7 refs.

The paper reports on an investigation of ac losses during pulsed operation of a 100 kJ superconducting energy storage system in which thyristors were used in place of a superconducting switch for peak shaving. The coil, which was not designed specifically for pulsed operation, was operated by trapezoidal current forms with various slopes. The coil was charged by rectifiers in the converter mode and discharged by them in the inverter mode. The ratio of electric power at charging and discharging was calculated as the energy storage efficiency, and experimental results were in good agreement with theoretical predictions. For a scale larger than 30 MWh for peak shaving, the prediction equation indicates 90% efficiency. A 3-MJ pulsed energy storage coil is under construction, which will be divided into three sections in order to protect the coil from quenching. The superconductor is Nb-Ti and the Cu/SC ratio is 3.0. P.T.H.

**A79-20538** Heat pulses required to quench a potted superconducting magnet. M. J. Superczynski (U.S. Naval Material Command, David W. Taylor Naval Ship Research and Development Center, Annapolis, Md.). (*Applied Superconductivity Conference, Pittsburgh, Pa., Sept. 25-28, 1978.*) *IEEE Transactions on Magnetism*, vol. MAG-15, Jan. 1979, p. 325-327.

A potted superconducting magnet was constructed and tested to determine the amount of energy, resulting from heat inputs to the magnet that tend to drive the magnet normal, required to quench the magnet. The solenoidal coil consisted of a 0.5-mm diameter multifilamentary NbTi superconductor in a copper matrix, where the copper to superconductor ratio was 1.8:1, with 180 filaments and a twist pitch of 1 cm. The magnet was reinforced with fiberglass cloth and impregnated with epoxy resin. Energy pulses of different widths under different magnetic fields and current levels were input to the magnet to provide a wide spectrum of possible disturbances that could initiate a quench. Reducing the magnet design margin by increasing  $I/I_{\text{critical}}$  above 0.75 will severely reduce the stability of the magnet system. The absolute energy required to quench a magnet can be increased by reducing the overall current density or improving the thermal diffusivity of the total coil structure. P.T.H.

**A79-20541** The role of the Large Coil Program in the development of superconducting magnets for fusion reactors. P. N.

Haubenreich, J. N. Luton, and P. B. Thompson (Oak Ridge National Laboratory, Oak Ridge, Tenn.). (*Applied Superconductivity Conference, Pittsburgh, Pa., Sept. 25-28, 1978.*) *IEEE Transactions on Magnetism*, vol. MAG-15, Jan. 1979, p. 520-524. 7 refs. Contract No. W-7405-eng-26.

Toroidal field coils in a tokamak reactor face special problems of heat generation by pulsed poloidal fields, demands for continuity of operation, structural design to handle the asymmetric in-plane loading and the out-of-plane forces repeatedly imposed, and space competition that makes high current densities desirable. Large coils meeting tokamak requirements must be built and tested before an optimal choice can be made. This is being done through the LCP (Large Coil Program), in which three U.S. industrial teams are designing and will build one coil each to a common set of specifications. Each test coil will have a 2.5 x 3.5 m D-shape bore, will contain about 7 MA-turns, and must operate at a peak field of 8 T while subjected to pulsed fields up to 0.14 T in a test stand that can accommodate up to 6 coils in a compact toroidal array. Two coils will use different NbTi conductors cooled by pool-boiling helium, while the third will use Nb3Sn cooled by a forced flow of supercritical helium. (Author)

**A79-20542** Superconductivity for mirror fusion. C. D. Henning (California, University, Livermore, Calif.). (*Applied Superconductivity Conference, Pittsburgh, Pa., Sept. 25-28, 1978.*) *IEEE Transactions on Magnetism*, vol. MAG-15, Jan. 1979, p. 525-529. 11 refs. Contract No. W-7405-eng-48.

The largest advance in fusion magnets will be used in the Mirror Fusion Test Facility (MFTF) now under construction at LLL. Improvements in the technology of the previous LLL experiment, Baseball II, have been made using new conductor joining techniques, a ventilated wrap-around copper stabilizer, and stronger structural welding methods. The MFTF coil winding is proceeding on a separate former to allow parallel construction of the main structure. Not only does this shorten the project schedule to equal that of other conventional constructions, but a second vacuum barrier is created between the magnet helium and the plasma environment for reliable operation. In the future, LLL envisions a superconducting version of the Tandem Mirror Experiment and a possible hybrid reactor leading to economical fusion power. (Author)

**A79-20543** Conceptual design of a superconducting tokamak - 'TORUS II SUPRA'. R. Aymar, G. Claudet, C. Deck, R. Duthil, P. Genevey, C. Leloup, J. C. Lottin, J. Parain, P. Seyfert, and A. Torossian (EURATOM and Commissariat à l'Energie Atomique sur la Fusion, Departement de Physique du Plasma et de la Fusion Contrôlée, Fontenay-aux-Roses, Hauts-de-Seine, France). (*Applied Superconductivity Conference, Pittsburgh, Pa., Sept. 25-28, 1978.*) *IEEE Transactions on Magnetism*, vol. MAG-15, Jan. 1979, p. 542-545. 6 refs.

The conceptual design of TORUS II SUPRA concerns a large-sized tokamak of the next generation. It takes into account constraints coming from the envisaged superconducting toroidal magnet, but keeps unchanged all the operational facilities and working conditions which a more conventional design, i.e., a water-cooled copper magnet, could offer. The main parameters are main radius equals 2.15 m, maximum plasma radius equals 0.75 m, magnetic field equals 4.5 T,  $I$  equals 1.7 MA. The scientific aims of the device concern the development, at a multimewatt level, of plasma heating methods, mainly wave absorption and the contribution to high temperature (3-5 keV) tokamak physics allowed by these methods: main emphasis is put on tentative profile control of plasma parameters during the quasi-steady state possible with a dc toroidal magnetic field. (Author)

**A79-20549** MIT-DOE program to demonstrate an advanced superconducting generator. J. L. Smith, Jr., G. L. Wilson, and J. L. Kirtley, Jr. (MIT, Cambridge, Mass.). (*Applied Superconductivity Conference, Pittsburgh, Pa., Sept. 25-28, 1978.*) *IEEE Transactions on Magnetism*, vol. MAG-15, Jan. 1979, p. 727-730. 13 refs. Research supported by the U.S. Department of Energy.

A program is described which focuses on the construction of a 10-MVA experimental superconducting generator. The proposed machine incorporates advances in shielding of the superconducting winding, superconducting-winding design, rotor design, cryogenic cooling system, and high-voltage armature design. An overview of the experimental generator is given, emphasizing steady-state losses, dissipation, the two separate experimental damping systems, and armature cooling. Problems are considered which involve the losses associated with a step change in the field applied outside the field winding and its shielding system as well as the effect of the rotation of an externally applied magnetic-field vector relative to the superconductor. A three-dimensional finite-element program that models eddy currents in the conducting shells is discussed. F.G.M.

**A79-20555** 30-MJ superconducting magnetic energy storage /SMES/ unit for stabilizing an electric transmission system. J. D. Rogers, H. J. Boenig, J. C. Bronson, D. B. Colyer, W. V. Hassenzahl, R. D. Turner, and R. I. Schermer (California, University, Los Alamos, N. Mex.). (*Applied Superconductivity Conference, Pittsburgh, Pa., Sept. 25-28, 1978.*) *IEEE Transactions on Magnetics*, vol. MAG-15, Jan. 1979, p. 820-823. 13 refs. Research sponsored by the U.S. Department of Energy.

Electric power systems that have major loads and generation centers separated by large distances may experience low-frequency power oscillations. This type of oscillation has occurred on the Pacific AC Intertie that connects southern California and the Pacific Northwest. A separate almost-parallel dc transmission line also connects these areas. The Bonneville Power Administration, which operates this transmission system, has overcome the instability by controlling the power transmitted on the dc transmission line. A 30-MJ (8.4-kWh) superconducting magnetic energy storage unit with a 10-MW converter could also provide damping for this instability. The conceptual design of the 30-MJ coil and the cryogenic and electrical components of the system are described. The system is to operate at a maximum current of 5 kA and will modulate the AC Intertie at 0.35 Hz. Discharge will be controlled to retain a minimum stored energy of 20 MJ to limit cyclic strains in the coil and ac losses in the conductor. The conductor will be made of multistrand-copper and copper-matrix multifilament NbTi superconducting wires on a stainless steel mandrel. (Author)

**A79-20557** SLPX - Superconducting Long-Pulse Tokamak Experiment. D. L. Jassby, J. File, G. Bronner, J. R. Clarke, H. G. Johnson, G. D. Martin, J. G. Murray, M. Okabayashi, W. G. Price, Jr., and P. Rogoff (Princeton University, Princeton, N.J.). (*Applied Superconductivity Conference, Pittsburgh, Pa., Sept. 25-28, 1978.*) *IEEE Transactions on Magnetics*, vol. MAG-15, Jan. 1979, p. 847-850. 5 refs. Contract No. EY-76-C-02-3073.

The principal objectives of the SLPX (Superconducting Long-Pulse Experiment) are: (1) to demonstrate quasi-steady operation of 3 to 5 MA hydrogen and deuterium tokamak plasmas at high temperature and high thermal wall loading, and (2) to develop reliable operation of prototypical tokamak reactor magnetics systems featuring a toroidal assembly of high-field niobium-tin coils, and a system of pulsed niobium-titanium superconducting poloidal-field coils. This paper describes the status of the engineering design features of the SLPX, with emphasis on the magnetics systems. The toroidal-field coils have an aperture of 3.1 m x 4.8 m, and can operate with a maximum field at the conductor of 12 T. The superconducting poloidal field magnetics system consists of a pulsed NbTi central solenoid, and a set of dc NbTi equilibrium-field coils. The entire machine is enclosed in an outer vacuum container equipped with re-entrant ports that provide ambient access to the room-temperature plasma vessel. (Author)

**A79-20658** # Electromagnetic excitation of a moving conducting piston (*Elektromagnitnoe vozbuzhdenie dvizhushchegosia provodiashchego porshnia*). V. T. Chemeris and S. A. Gavrilko (Akademiia Nauk Ukrainskoi SSR, Institut Elektrodinamiki, Kiev,

Ukrainian SSR). *Problemy Tekhnicheskoi Elektrodinamiki*, no. 66, 1978, p. 90-97. 10 refs. In Russian.

A theoretical analysis is presented of the cross-sectional current density distribution of a conducting piston moving in an external magnetic field in a pulsed induction-type MHD generator. Consideration is given to the difficulty of formulating boundary conditions for the current, associated with the necessity of preliminary determination of the rate of magnetic field diffusion into the piston. A mathematical model for calculating the rate of field diffusion as well as the distribution of current and fields in the piston and channel walls is presented. B.J.

**A79-20679** # New chemical sources of current (*Novye khimicheskie istochniki toka*). N. V. Korovin. Moscow, Izdatel'stvo Energiia, 1978. 184 p. 111 refs. In Russian.

The work describes the principles of operation of such devices as fuel cells, galvanic cells, and electrochemical generators. Particular consideration is given to the use of nonaqueous and solid electrolytes, the use of lithium-magnesium electrodes, the magnesium water-activated battery, thermal batteries, and hydrocarbon-air fuel cell batteries. Various applications of such devices are reviewed, including power plants and spacecraft power systems. B.J.

**A79-20700** \* Energy conservation through sealing technology. W. K. Stair (Tennessee, University, Knoxville, Tenn.) and L. P. Ludwig (NASA, Lewis Research Center, Cleveland, Ohio). (*American Society of Lubrication Engineers, Annual Meeting, 33rd, Dearborn, Mich., Apr. 17-20, 1978.*) *Lubrication Engineering*, vol. 34, Nov. 1978, p. 618-624. 12 refs.

Improvements in fluid film sealing resulting from a proposed research program could lead to an annual energy saving, on a national basis, equivalent to about 37 million bbl of oil or 0.3% of the total U.S. energy consumption. Further, the application of known sealing technology can result in an annual saving of an additional 10 million bbl of oil. The energy saving would be accomplished by reduction in process heat energy loss, reduction of frictional energy generated, and minimization of energy required to operate ancillary equipment associated with the seal system. In addition to energy saving, cost effectiveness is further enhanced by reduction in maintenance and in minimization of equipment for collecting leakage and for meeting environmental pollution standards. (Author)

**A79-20729** Tidal power in the Bay of Fundy. G. F. D. Duff (Toronto, University, Toronto, Canada). *Technology Review*, vol. 81, Nov. 1978, p. 34-42. 8 refs.

Details on the exploration of tidal energy, followed by a discussion of tidal technology and of the causes of tidal phenomena are presented with emphasis placed on the projected tidal power plant at Cumberland Basin on the Bay of Fundy, Canada, which will have a capacity of 1,085 MW. It has been estimated that for a 30-year period the cost/benefit ratio for the Cumberland Basin plant will be at 1:1.2. Beyond the electrical power that will be generated by the Cumberland Basin plant, a saving of 3 million barrels of fuel oil annually and of 380,000 tons of coal and some nuclear fuel would also be realized through the use of the power plant. Following the design, the plant will use a 'single effect' tidal barrier and a single basin to moderate the flow of tidal water. Construction could involve either of three methods: (1) floating in bulb turbines mounted in caissons, (2) building power houses and sluices behind dewatered cofferdams, and (3) building the power houses and sluices underground in a convenient headland and later removing natural rock plugs to open passageways for the water. The effects that the power plant might have on the environment are being studied though it is known that tidal power has minimal environmental side effects. A.A.

**A79-20730** Thermoclines: A solar thermal energy resource for enhanced hydroelectric power production. J. L. McNichols, W. S. Ginell (McDonnell Douglas Astronautics Co., Huntington Beach, Calif.), and J. S. Cory (Cory Laboratories, Escondido, Calif.). *Science*, vol. 203, Jan. 12, 1979, p. 167, 168. 6 refs.



It is suggested that the solar thermal energy stored in hydroelectric reservoir freshwater thermoclines be used to increase the power output of conventional hydroelectric plants. Estimates of the amount of thermal energy stored and the efficiency of conversion into mechanical energy are considered, and thermocline data for three large reservoirs in western U.S. are presented. The adaptation of heat to hydroelectric facilities is recommended. M.L.

**A79-20746** Magnetic multipole line-cusp plasma generator for neutral beam injectors. W. L. Stirling, P. M. Ryan, C. C. Tsai, and K. N. Leung (Oak Ridge National Laboratory, Oak Ridge, Tenn.). *Review of Scientific Instruments*, vol. 50, Jan. 1979, p. 102-108. 19 refs. Contract No. W-7405-eng-26.

The magnetic multipole line-cusp device developed by MacKenzie and associates has been adapted for use as a neutral beam ion source. It has produced high-density, large volume, quiescent, uniform hydrogen plasmas, which makes it a potential candidate for use as a plasma generator for neutral beam injectors. The device is a water-cooled cylindrical copper discharge chamber (25 cm in diameter by 36 cm long) with one end enclosed by a set of extraction grids with a 15-cm-diam multiaperture pattern. The chamber wall serves as an anode and is surrounded by an external system of rare-earth cobalt magnets arranged in a line-cusp geometry of 12 cusps; plasma is produced by electron emission from a hot cathode assembly. This source has achieved extracted beam currents of 12 A at 18.5 kV, radial plasma density uniformities of  $\pm 5\%$  over a 15-cm diameter, noise levels of less than  $\pm 0.5\%$ , and arc efficiencies (beam current/arc power) of 0.6 A/kW. (Author)

**A79-20770** The thermochemical decomposition of water using bromine and iodine. S. Mizuta, W. Kondo, T. Kumagai, and K. Fujii (National Chemical Laboratory for Industry, Tokyo, Japan). *International Journal of Hydrogen Energy*, vol. 3, Dec. 11, 1978, p. 407-417. 19 refs.

Thermochemical hydrogen production by the decomposition of water in a closed cycle that uses the combination of bromine or iodine with alkaline-earth metals was investigated. A thermodynamic analysis of the suitability of alkaline-earth metals to the bromine and iodine cycles is presented. These cycles consist of: the redox reaction of bromine (iodine), thermal decomposition of bromate (iodate), hydrolysis of bromide (iodide) and the thermal dissociation of hydrogen bromide (iodide). As a result of preliminary experiments, five new cycles (Mg-Ba-Br cycle, Mg-K-Br cycle, Mg-I cycle, Mg-Ca-I cycle and Mg-Ba-I cycle) are presented. (Author)

**A79-20771** Problems around Fe-Cl cycles. D. van Velzen and H. Langenkamp (EURATOM and Comitato Nazionale per l'Energia Nucleare, Centro Comune di Ricerca, Ispra, Italy). *International Journal of Hydrogen Energy*, vol. 3, Dec. 11, 1978, p. 419-429. 21 refs.

Cycles for the thermochemical decomposition of water belonging to the Fe-Cl family have been considered potentially attractive. An analysis of the thermal efficiency, investments costs and development potential of this family is presented, where electrolysis of water serves as a reference process. It is concluded that the thermal efficiency of these cycles is probably considerably below the values obtained with direct electrolysis whereas investment costs are presumably higher by a factor of more than two. Main problem areas are situated in the hydrolysis of FeCl<sub>2</sub> as well as in the thermal decomposition of FeCl<sub>3</sub>. Both problems have to be solved simultaneously; finding a solution to only one will not be sufficient to build an attractive process. A number of possible alternative solutions to these problems are discussed. (Author)

**A79-20772** Thermodynamics of pressure plateaus in metal-hydrogen systems. P. S. Rudman (Technion - Israel Institute of Technology, Haifa, Israel). *International Journal of Hydrogen Energy*, vol. 3, Dec. 11, 1978, p. 431-447. 8 refs. Research supported by the National Council for Research and Development and Kernforschungsanlage Jülich GmbH.

**A79-20773** The potential of liquid hydrogen as a military aircraft fuel. W. T. Mikolowsky (Rand Corp., Washington, D.C.) and L. W. Noggle (USAF, Wright-Patterson AFB, Ohio). *International Journal of Hydrogen Energy*, vol. 3, Dec. 11, 1978, p. 449-460. 15 refs.

The paper is concerned with the possible use of liquid hydrogen as a fuel for very large aircraft (with maximum gross weights in excess of one million pounds). Life-cycle costs and life-cycle energy consumption for both synthetic jet-fuel and liquid hydrogen-fueled aircraft are compared, and it is found for these coal-derived fuels that synthetic jet fuel is more attractive than liquid hydrogen as a military aircraft fuel. Strategic airlift mission and station-keeping missions are considered. M.L.

**A79-20774** Some environmental and safety aspects of using hydrogen as a fuel. G. D. Brewer (Lockheed-California Co., Burbank, Calif.). (Commission of the European Communities, EURATOM Course, Ispra, Italy, May 9-13, 1977.) *International Journal of Hydrogen Energy*, vol. 3, Dec. 11, 1978, p. 461-474. 7 refs.

The use of hydrogen as a fuel for road vehicles and for aircraft is discussed from the viewpoint of environmental and safety considerations. The current pattern of hydrogen use in industrial processes is described, and the use of hydrogen for energy transmission and for household appliances is considered. The problem of air pollution from aircraft is examined. M.L.

**A79-20796** Experimental studies of a linear MHD generator with fully ionized seed. H. Yamasaki, S. Shioda (Tokyo Institute of Technology, Tokyo, Japan), and Y. Masuhara. *Journal of Energy*, vol. 2, Nov.-Dec. 1978, p. 337-341. 11 refs.

Power generation experiments for a linear nonequilibrium Faraday generator with small seed fractions of .00001-.0001 have been conducted in order to show the recovery of the effective electrical conductivity and the power density due to the suppression of ionization instability and to demonstrate the possible operation of a linear MHD generator with fully ionized seed. Results of the experiments have shown the recovery of the apparent conductivity up to 20-27 mho/m, and the ratio of the apparent conductivity to the ideal conductivity decreases from 0.8 to 0.2 as the seed fraction increases from .00001-.00007. The high apparent conductivity indicates the possible operation of a linear generator with fully ionized seed, and the increase of isentropic efficiency of a closed-cycle inert-gas MHD generator can be expected. (Author)

**A79-20798** Fluid dynamics of diffuser-augmented wind turbines. B. L. Gilbert, R. A. Oman, and K. M. Foreman (Grumman Fluid Dynamics Laboratory, Bethpage, N.Y.). *Journal of Energy*, vol. 2, Nov.-Dec. 1978, p. 368-374. 6 refs. Contract No. E(11-1)-2616.

The diffuser-augmented wind turbine (DAWT) is one of the advanced concepts being investigated to improve the economics of wind energy conversion systems (WECS). Application of modern boundary-layer control techniques has reduced the surface area requirements of an efficient diffuser by an order of magnitude. Many parameters that affect the performance of the diffuser system have been examined in small-scale wind tunnel tests with a family of compact diffusers, using screens and centerbodies to simulate the presence of turbine. Flowfield surveys, overall performance, the effect of ground proximity, and the prospects for further improvement are described. The baseline configuration is a conical, 60 deg included angle diffuser with an area ratio of 2.78 controlled by two tangential injection slots. This first-generation DAWT can provide about twice the power of a conventional WECS with the same turbine diameter and wind. Economic estimates show that this DAWT can be as much as 50% cheaper than conventional WECS for the same rated power. (Author)

**A79-20799** Universal generator storer curves. A. V. da Rosa (CODETEC, Brazil; Stanford University, Stanford, Calif.). *Journal of Energy*, vol. 2, Nov.-Dec. 1978, p. 381, 382.

Some considerations regarding the optimization of relative sizes of generator and energy storage device of a solar photovoltaic system are presented. Curves are presented plotting the normalized effective collector area versus storage capacity and system cost versus peak array power for two different storage-system costs. B.J.

**A79-20800 #** An inverse problem of vertical-axis wind turbines. J. V. Healy (Belfast, Queen's University, Belfast, Northern Ireland). *Journal of Energy*, vol. 2, Nov.-Dec. 1978, p. 382-384. 5 refs.

The problem of choosing the most desirable lift and drag forces for a vertical-axis wind turbine is examined. The solution is obtained simply by specifying  $A = 1/3$  and  $C(p) = 16/27$  (where  $A$  is the inflow factor and  $C(p)$  is the maximum theoretical power coefficient), and solving for the lift and drag coefficients and the corresponding value of the angle of attack. It is found that even if it were possible to vary the angle of attack with angular position around the blade path, it would still be impossible to extract all the available energy. With the angle between the chord-line and the radial line fixed, this reduces the possibilities even further. B.J.

**A79-20801** Selective application of materials for products and energy; Proceedings of the Twenty-third National Symposium and Exhibition, Anaheim, Calif., May 2-4, 1978. Symposium sponsored by the Society for the Advancement of Material and Process Engineering, Azusa, Calif., Society for the Advancement of Material and Process Engineering (Science of Advanced Materials and Process Engineering Series, Volume 23), 1978. 1257 p. \$40.

The commercial application of aerospace technology is considered along with the manufacturing cost/design guide, structural composites and adhesive materials, the fabrication of composite shell structure for advanced space transportation, aspects of testing, the role of materials in solar energy conversion, questions of windmill technology, new matrix materials for advanced composites, recent developments in the microstructural characterization of corrosion processes, and questions of high temperature corrosion. Attention is given to composite flywheels for energy storage, micro and macro mechanics formulas for composite materials, the flammability and toxicity of materials, advanced composite material in aircraft engines, sporting goods applications, the electromagnetic properties of composite and insulating materials, advanced composite material in aircraft and helicopters, and dimensionally stable structures. G.R.

**A79-20821 \*** Recent developments in low cost silicon solar cells for terrestrial applications. M. H. Leipold. In: Selective application of materials for products and energy; Proceedings of the Twenty-third National Symposium and Exhibition, Anaheim, Calif., May 2-4, 1978. Azusa, Calif., Society for the Advancement of Material and Process Engineering, 1978, p. 354-365. 33 refs. Research sponsored by the U.S. Department of Energy; Contract No. NAS7-100.

A variety of techniques may be used for photovoltaic energy systems. Concentrated or not concentrated sunlight may be employed, and a number of materials can be used, including silicon, gallium arsenide, cadmium sulfide, and cadmium telluride. Most of the experience, however, has been obtained with silicon cells employed without sunlight concentration. An industrial base exists at present for producing solar cells at a price in the range from \$15 to \$30 per peak watt. A major federal program has the objective to reduce the price of power provided by silicon solar systems to approximately \$1 per peak watt in the early 1980's and \$0.50 per watt by 1986. The approaches considered for achieving this objective are discussed. G.R.

**A79-20822** A ceramic heat exchanger for a Brayton cycle solar electric power plant. J. D. Walton and J. N. Harris (Georgia Institute of Technology, Atlanta, Ga.). In: Selective application of materials for products and energy; Proceedings of the Twenty-third

National Symposium and Exhibition, Anaheim, Calif., May 2-4, 1978. Azusa, Calif., Society for the Advancement of Material and Process Engineering, 1978, p. 366-374. Research sponsored by the Electric Power Research Institute.

Solar thermal electric power systems collect and concentrate solar energy to heat a working fluid which is used to drive conventional Rankine or Brayton cycle turbine-generator equipment. A principal advantage of the central receiver system is the very high temperatures that can be produced in the working fluid. However, commercially available high temperature metal tube materials are not suitable for extended operation above about 1600 F. at the stress level expected in the high temperature heat exchanger. An investigation was, therefore, conducted with the objective to study suitable ceramic materials. It was found that silicon carbide U-tubes are suitable for use in a solar central receiver cavity type heat exchanger. G.R.

**A79-20823 #** Suitable optical materials for solar collector applications. J. E. Gilligan and J. Brzuskiwicz (IIT Research Institute, Chicago, Ill.). In: Selective application of materials for products and energy; Proceedings of the Twenty-third National Symposium and Exhibition, Anaheim, Calif., May 2-4, 1978. Azusa, Calif., Society for the Advancement of Material and Process Engineering, 1978, p. 375-385. Contract No. EY-76-C-02-0578-034.

The primary purpose of the described program is to determine the properties of solar energy utilization materials before and after exposure to outdoor weathering, and to obtain other relevant information including materials cost and availability. Ultimately, this program will provide designers and manufacturers of Solar Utilization (SU) devices with the appropriate data in handbook form to select cost-effective materials for their particular engineering designs, locations, and environments. Attention is given to the basic properties, nomenclature and measurement geometries, and bidirectional measurements. It is found that the role of materials in SU applications relates strongly to their initial properties, and to their durability. G.R.

**A79-20824** The thermomechanical behavior of polyvinyl butyral film and its effect on focal stability of a solar mirror-laminate. A. M. Lindrose and T. R. Guess (Sandia Laboratories, Albuquerque, N. Mex.). In: Selective application of materials for products and energy; Proceedings of the Twenty-third National Symposium and Exhibition, Anaheim, Calif., May 2-4, 1978. Azusa, Calif., Society for the Advancement of Material and Process Engineering, 1978, p. 386-402. Research supported by the U.S. Department of Energy.

**A79-20825 \*** Background and system description of the Mod 1 wind turbine generator. E. H. Ernst (General Electric Co., Valley Forge, Pa.). In: Selective application of materials for products and energy; Proceedings of the Twenty-third National Symposium and Exhibition, Anaheim, Calif., May 2-4, 1978. Azusa, Calif., Society for the Advancement of Material and Process Engineering, 1978, p. 403-408. Contract No. NAS3-20058.

The Mod-1 wind turbine considered is a large utility-class machine, operating in the high wind regime, which has the potential for generation of utility grade power at costs competitive with other alternative energy sources. A Mod-1 wind turbine generator (WTG) description is presented, taking into account the two variable-pitch steel blades of the rotor, the drive train, power generation/control, the Nacelle structure, and the yaw drive. The major surface elements of the WTG are the ground enclosure, the back-up battery system, the step-up transformer, elements of the data system, cabling, area lighting, and tower foundation. The final system weight (rotor, Nacelle, and tower) is expected to be about 650,000 pounds. The WTG will be capable of delivering 1800 kW to the utility grid in a wind-speed above 25 mph. G.R.

**A79-20826 \*** Wind turbine generator application places unique demands on tower design and materials. J. P. Kita (General Electric Co., Space Div., Valley Forge, Pa.). In: Selective application of materials for products and energy; Proceedings of the Twenty-third National Symposium and Exhibition, Anaheim, Calif., May 2-4, 1978. Azusa, Calif., Society for the Advancement of Material and Process Engineering, 1978, p. 409-416. Contract No. NAS3-20058.

The most relevant contractual tower design requirements and goal for the Mod-1 tower are related to steel truss tower construction, cost-effective state-of-the-art design, a design life of 30 years, and maximum wind conditions of 120 mph at 30 feet elevation. The Mod-1 tower design approach was an iterative process. Static design loads were calculated and member sizes and overall geometry chosen with the use of finite element computer techniques. Initial tower dynamic characteristics were then combined with the dynamic properties of the other wind turbine components, and a series of complex dynamic computer programs were run to establish a dynamic load set and then a second tower design. G.R.

**A79-20827 \*** Fatigue impact on Mod-1 wind turbine design. C. V. Stahle, Jr. (General Electric Co., Space Div., Valley Forge, Pa.). In: Selective application of materials for products and energy; Proceedings of the Twenty-third National Symposium and Exhibition, Anaheim, Calif., May 2-4, 1978. Azusa, Calif., Society for the Advancement of Material and Process Engineering, 1978, p. 417-427. Contract No. NAS3-20058.

Fatigue is a key consideration in the design of a long-life Wind Turbine Generator (WTG) system. This paper discusses the fatigue aspects of the large Mod-1 horizontal-axis WTG design starting with the characterization of the environment and proceeding through the design. Major sources of fatigue loading are discussed and methods of limiting fatigue loading are described. NASTRAN finite element models are used to determine dynamic loading and internal cyclic stresses. Recent developments in determining the allowable fatigue stress consistent with present construction codes are discussed relative to their application to WTG structural design. (Author)

**A79-20828 \*** Wind-turbine-generator rotor-blade concepts with low-cost potential. T. L. Sullivan, T. P. Cahill (NASA, Lewis Research Center, Cleveland, Ohio), D. G. Griffie, Jr. (NASA, Lewis Research Center, Cleveland, Ohio; United Technologies Corp., Hamilton Standard Div., Windsor Locks, Conn.), and H. W. Gewehr (NASA, Lewis Research Center, Cleveland, Ohio; Kaman Aerospace Corp., Bloomfield, Conn.). In: Selective application of materials for products and energy; Proceedings of the Twenty-third National Symposium and Exhibition, Anaheim, Calif., May 2-4, 1978. Azusa, Calif., Society for the Advancement of Material and Process Engineering, 1978, p. 428-456.

Four processes for producing blades are examined. Two use filament winding techniques and two involve filling a mold or form to produce all or part of a blade. The processes are described and a comparison is made of costs, material properties, designs and free vibration characteristics. Conclusions are made regarding the feasibility of each process to produce low-cost, structurally adequate blades. (Author)

**A79-20829 \*** An operating 200 kW horizontal axis wind turbine. C. L. Hunnicutt (Lockheed Aircraft Service Co., Ontario, Calif.), B. Linscott, and R. A. Wolf (NASA, Lewis Research Center, Cleveland, Ohio). In: Selective application of materials for products and energy; Proceedings of the Twenty-third National Symposium and Exhibition, Anaheim, Calif., May 2-4, 1978. Azusa, Calif., Society for the Advancement of Material and Process Engineering, 1978, p. 457-478.

Output from the 200-kilowatt machine will be enough to meet the power requirements of about 60 families. The experimental wind turbine generator (WTG) is a two-bladed, horizontal-axis, rotor system driving a synchronous electric generator through a step-up gear box located within a nacelle. The nacelle is mounted on top of a 100-foot tower with the rotor located downwind from the tower.

The 200-kilowatt rated power output of the wind turbine is achieved at a turbine rotor speed of 40 rpm and a rated wind speed of 18.3 mph. The rated wind speed is defined as the lowest wind speed at which full power is achieved. Attention is given to operational details, aspects of blade design, blade fabrication, the use of strain gages, questions of aeroelastic stability, and an early analysis of test data. G.R.

**A79-20838** Preliminary analysis of advanced ceramic magnetohydrodynamic (MHD) combustor design concepts. E. L. Paquette (Atlantic Research Corp., Alexandria, Va.). In: Selective application of materials for products and energy; Proceedings of the Twenty-third National Symposium and Exhibition, Anaheim, Calif., May 2-4, 1978. Azusa, Calif., Society for the Advancement of Material and Process Engineering, 1978, p. 642-650.

The following design concepts of advanced ceramic MHD combustors are examined for engineering feasibility: uncooled ceramic-lined combustor, transpirationally cooled ceramic wall combustor, transpirationally shielded or consumable wall ceramic-lined combustors, and steam or air cooled ceramic-lined combustors. Feasible applications of ceramics to these design concepts are discussed. It is shown that the transpirationally cooled or shielded and the consumable wall ceramic-lined combustor concepts are impractical in terms of required flows, material removal rates, economics and reliability. The steam and air cooled ceramic-lined combustors appear to have immediate engineering feasibility. The uncooled ceramic design concept remains viable and essentially dependent on advances in ceramic material development related to selections. S.D.

**A79-20840** A composite-rim flywheel design. E. D. Reedy, Jr. (Sandia Laboratories, Albuquerque, N. Mex.). In: Selective application of materials for products and energy; Proceedings of the Twenty-third National Symposium and Exhibition, Anaheim, Calif., May 2-4, 1978. Azusa, Calif., Society for the Advancement of Material and Process Engineering, 1978, p. 663-674. 15 refs. Research supported by the U.S. Department of Energy.

The design of a flywheel incorporating a circumferentially wound rim is described. The flywheel is required to satisfy weight and size limitations which seem appropriate for utilization in a hybrid vehicle. Attention is given to the selection of materials and configuration for rim and hub, and to a method of attaching the rim to the hub. The rim material and design are chosen to optimize the rotor's energy storage capacity. Also, a method of fabricating prototype flywheels is described. Analysis of constant-thickness rims identified a graphite/epoxy rim with an inner-to-outer radius ratio of 0.775 as having the highest energy storage capacity of all design and material choices considered. This rim is used as the basis of a thick-rim flywheel design. The wagon wheel design incorporates a tubular aluminum hub and overwrapped Kevlar 49/epoxy bands. At 32,000 rpm, this flywheel can deliver 0.5-kWh energy with a three to one speed reduction. S.D.

**A79-20842** Composite material flywheel for the electric-powered passenger vehicle. D. A. Towgood and D. L. Satchwell (AiResearch Manufacturing Company of California, Torrance, Calif.). In: Selective application of materials for products and energy; Proceedings of the Twenty-third National Symposium and Exhibition, Anaheim, Calif., May 2-4, 1978. Azusa, Calif., Society for the Advancement of Material and Process Engineering, 1978, p. 703-711.

AiResearch has successfully operated a 23-in.-diameter, Kevlar-reinforced, epoxy flywheel in a design evaluation test for the Department of Energy electric-powered passenger vehicle. This composite material flywheel was subjected to 1000 deep acceleration-deceleration cycles of 12,500 to 25,000 rpm for two weeks. These accelerated life cycles represent an expected vehicle life of 10 years. The multiring flywheel is rim-mounted on a four-spoke aluminum hub. The rim comprises a set of nested, S-2 fiberglass

epoxy rings reinforced with Kevlar 29 and Kevlar 49. Candidate materials considered for this design will be compared in terms of mechanical properties and relative material costs per unit of stored energy. (Author)

**A79-20843** A status of the 'Aloha-ply' composite flywheel concept development. E. L. Lustenader and E. S. Zorzi (General Electric Co., Fairfield, Conn.). In: Selective application of materials for products and energy; Proceedings of the Twenty-third National Symposium and Exhibition, Anaheim, Calif., May 2-4, 1978. Azusa, Calif., Society for the Advancement of Material and Process Engineering, 1978, p. 712-727.

The development of the pseudo-isotropic flywheel concept 'Alpha-ply' is discussed. Analytic and experimental results are presented, and the finite-element evaluation of the concept is described. The construction of the low-cost reliable and moderate-energy-density flywheel (potential energy density as high as 30 Wh/lb) consists of a layup of composite glass material into a uniform thickness disk. Reasons for the failure of the first 30-in. od E-glass/Kevlar-wrapped alpha 2 wheel are suggested. M.L.

**A79-20845** Flywheel energy accumulators for road vehicles. G. Hanselmann and E. Hau (M.A.N. Neue Technologie, Munich, West Germany). In: Selective application of materials for products and energy; Proceedings of the Twenty-third National Symposium and Exhibition, Anaheim, Calif., May 2-4, 1978. Azusa, Calif., Society for the Advancement of Material and Process Engineering, 1978, p. 740-747.

The technology of flywheel energy accumulators is discussed with reference to application in road vehicles. Choice of material, bearings and housing, safety, and cost of flywheels made from carbon or glass fibers are considered. The incorporation of a flywheel accumulator in drive systems containing either an internal combustion engine or a battery is examined, and the advantages provided by the flywheel are described. M.L.

**A79-20852** Composite material flywheels for energy storage on electricity supply systems. P. J. Worthington (Central Electricity Generating Board, Research Laboratories, Leatherhead, Surrey, England). In: Selective application of materials for products and energy; Proceedings of the Twenty-third National Symposium and Exhibition, Anaheim, Calif., May 2-4, 1978. Azusa, Calif., Society for the Advancement of Material and Process Engineering, 1978, p. 846-855. 12 refs.

The paper assesses the use of composite-material flywheels for large-scale storage of electricity. To achieve useful storage of about 10 MWh, large composite-material components need to be constructed and supported, and ancillary equipment developed to extract power from the flywheels. In particular, the costs of this method of storage are considered in order to evaluate the economic aspect of composite flywheels. A curve for useful energy stored vs flywheel mass is presented for different materials - Kevlar/epoxy, carbon/epoxy, glass/epoxy (all with about 60 vol% fiber) and steel. Another curve for tension/tension fatigue properties of unidirectional composites, with about 60 vol% fiber is given. Both a radially thin hoop wound rim and rods of aligned fibers mounted in a sweep's brush configuration for composite flywheel construction are discussed. S.D.

**A79-20853** Current status of composite flywheel development. R. H. Toland (California, University, Livermore, Calif.). In: Selective application of materials for products and energy; Proceedings of the Twenty-third National Symposium and Exhibition, Anaheim, Calif., May 2-4, 1978. Azusa, Calif., Society for the Advancement of Material and Process Engineering, 1978, p. 856-876. 24 refs. Contract No. W-7405-eng-48.

The paper surveys the recent developments in the applications of fiber composite materials to flywheel energy storage systems. The impact of these materials on flywheel energy storage is discussed in relation to transportation systems, specifically the performance re-

quirements and the effect of system constraints on the ultimate effectiveness of the composite rotors. General flywheel design concepts are discussed in light of several performance criteria and the inherent design and material limitations, including those affecting reliability and life. Specific composite rotors that have been built and tested are discussed in terms of their demonstrated performance and are assessed for their potential. Also, recent government-sponsored research and development programs are briefly reviewed, and recommendations are made for future work. (Author)

**A79-20883** \* # Integral assembly of photovoltaic arrays using glass. P. R. Younger, A. R. Kirkpatrick (Spire Corp., Bedford, Mass.), H. G. Maxwell, and R. F. Holtze (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). Society for the Advancement of Material and Process Engineering, National Symposium and Exhibition, 23rd, Anaheim, Calif., May 2-4, 1978, Paper. 6 p. Research sponsored by the U.S. Department of Energy and NASA.

For a number of reasons glass is an excellent material for encapsulation of solar cell arrays. Glass can be readily available at relatively low cost. It exhibits excellent stability against degradation by solar ultraviolet illumination and atmospheric pollutants. A superior approach results if glass is employed directly as an integral encapsulant without secondary organic materials. A description is presented of a electrostatic bonding process which is being developed for integral assembly of glass encapsulated arrays. Solar cells are placed in contact with the glass surface, temperature is raised until the glass becomes ionically conductive, and an electric field is applied to initiate the bonding action. Silicon solar cells up to 3 inches in diameter have been integrally bonded without degradation. G.R.

**A79-20940** Optimization of a Knudsen Cs-Ba thermionic converter. V. I. Babanin, V. I. Kuznetsov, A. S. Mustafae, V. I. Sitnov, and A. Ia. Ender (Akademii Nauk SSSR, Fiziko-Tekhnicheskii Institut, Leningrad, USSR). (Zhurnal Tekhnicheskoi Fiziki, vol. 48, Apr. 1978, p. 754-766.) Soviet Physics - Technical Physics, vol. 23, Apr. 1978, p. 444-451. 16 refs. Translation.

Consideration is given to the optimization of the saturation current and the power of a Cs-Ba thermionic converter operating in the Knudsen mode with surface ionization. An analysis is presented of potential distribution in the region of transition from a super-compensated to a subcompensated mode. A method for optimizing saturation current is presented and the maximum current of the thermionic converter is compared with the chaotic current in an equilibrium isothermal cavity. In developing a power-optimization procedure, a general volt-ampere characteristic is introduced which is used to determine the anodic work function and output power. Experimental data agree well with computational results and indicate that a Cs-Ba converter is highly efficient. B.J.

**A79-20941** Optimization of an ideal thermionic converter. A. S. Titkov. (Zhurnal Tekhnicheskoi Fiziki, vol. 48, Apr. 1978, p. 767-769.) Soviet Physics - Technical Physics, vol. 23, Apr. 1978, p. 452, 453. 5 refs. Translation.

The problem of obtaining maximum output power is solved for an ideal thermionic converter with prescribed temperatures of emitter and collector and prescribed output current. An exact analytical expression is obtained for the limiting envelope of volt-ampere curves for an ideal converter; this expression can be used as a standard to evaluate the efficiency of real thermionic converters. As an example, calculations are conducted for the case of an emitter temperature of 2100 K and a collector temperature of 1050 K. A maximum output power of  $5 \times 10$  to the 8th W/sq cm is obtained. B.J.

**A79-21056** Differential insolation and turbidity measurements. N. S. Laulainen, E. W. Kleckner, and J. J. Michalsky (Battelle Pacific Northwest Laboratories, Richland, Wash.). In: Conference on Atmospheric Radiation, 3rd, Davis, Calif., June 28-30, 1978, Preprints. Boston, Mass., American Meteorological Society, 1978, p. 130-133. Contract No. EY-76-C-06-1830.

The Hanford area provides a unique opportunity for characterization of turbidity because of the nearly 1-km altitude difference between the Rattlesnake Observatory and the Hanford Meteorological Station, and because of the large variability of atmospheric dust and haze in the Central Columbia Basin region. An experiment was conducted during summer 1977 with several types of solar radiation instruments, including pyranometers, multiple-wavelength solar photometers, and an active cavity radiometer. The study demonstrates the usefulness of operating several different types of solar radiation instruments for obtaining insolation and turbidity simultaneously. The need for making measurements of total diffuse sky radiation is indicated. S.D.

**A79-21062** Measurement and modelling of shortwave radiation on inclined surfaces. J. E. Hay (British Columbia, University, Vancouver, Canada). In: Conference on Atmospheric Radiation, 3rd, Davis, Calif., June 28-30, 1978, Preprints. Boston, Mass., American Meteorological Society, 1978, p. 150-153.

At Vancouver UBC (49 deg 15 min N, 123 deg 15 min W) and Toronto Woodbridge (43 deg 48 min N, 79 deg 33 min W), essentially identical shortwave radiation measurement programs are providing observed values of inclined surface irradiance for direct input into numerical models and for testing slope radiation calculation procedures. The paper describes the instrumentation and some of the characteristics of the observed data, along with a comparison of these data with values calculated by a variety of numerical approaches. The effect of inclining the pyranometers is eliminated by using specific correction factors. The measured data are summarized by comparing monthly mean values for the horizontal and south-facing surfaces with long-term averaged values. Numerical modeling is discussed relative to direct radiation on a slope, reflected radiation on a slope, and diffuse radiation on a slope. An attempt to parameterize the ratio of circumsolar to isotropically distributed radiation has resulted in the development of a fourth model termed the anisotropic diffusion-radiation model, characterized by reduced systematic and random errors in the calculated total shortwave radiation. S.D.

**A79-21161** Analysis and design of a field of heliostats for a solar power plant. J. L. Abatut and A. Achaibou (CNRS, Laboratoire d'Automatique et d'Analyse des Systèmes, Toulouse, France). *Solar Energy*, vol. 21, no. 6, 1978, p. 453-463.

For the design of the mirror field for the CNRS (Centre National de la Recherche Scientifique) project of a several MWe solar energy conversion power plant, an analysis of this concentration system is proposed. Using simulation programs, the problems of the choice of an optimal height of the tower and a convenient slope of the field are solved. By analysing the variation of the thermal power during five test days, it is shown that subject to certain assumptions the maximum output power is about 10 MWe. (Author)

**A79-21162** The dependence of optical properties on the structural composition of solar absorbers - Gold black. P. O'Neill, A. Ignatiev, and C. Doland (Houston, University, Houston, Tex.). *Solar Energy*, vol. 21, no. 6, 1978, p. 465-468, 13 refs. Research supported by the University of Houston and ERDA.

**A79-21163** Optimal distribution of heat conducting material in the finned pipe solar energy collector. M. Kovarik (Commonwealth Scientific and Industrial Research Organization, Highett, Victoria, Australia). *Solar Energy*, vol. 21, no. 6, 1978, p. 477-484, 6 refs.

**A79-21164** Hourly vs daily method of computing insolation on inclined surfaces. M. Iqbal (British Columbia, University, Vancouver, Canada). *Solar Energy*, vol. 21, no. 6, 1978, p. 485-489, 14 refs. Research supported by the National Research Council of Canada.

Two methods of determining insolation on south-facing inclined planes are compared and are found to provide only slightly different results. One method uses hourly values of total and diffuse radiation obtained from experimental data, while the other procedure applies the Liu and Jordan method for obtaining daily insolation on surfaces tilted toward the equator. The differences in the calculated insolation are attributed to three factors, which are discussed. M.L.

**A79-21165** Computer based sun following system. B. P. Edwards (Australian National University, Canberra, Australia). *Solar Energy*, vol. 21, no. 6, 1978, p. 491-496, 6 refs.

A computer-based system controlling a large number of paraboloid collectors for sunfollowing operation is examined. The system operates with the computer changing the speeds of each of the collector actuators in the field at regular intervals over the day. Sources of following error and procedures for minimizing the error are described. Accurate sun following is shown to require a data output from the central controller of only 500 bit/sec for 10,000 collectors. A computer-based learning procedure functionally equivalent to an alignment process is considered. M.L.

**A79-21166** Augmented solar energy collection using different types of planar reflective surfaces - Theoretical calculations and experimental results. D. P. Grimmer (California, University, Los Alamos, N. Mex.), K. G. Zinn (California, University, La Jolla, Calif.), K. C. Herr (Aerospace Corp., Los Angeles, Calif.), and B. E. Wood (Oregon, University, Eugene, Ore.). *Solar Energy*, vol. 21, no. 6, 1978, p. 497-501, 9 refs. ERDA-sponsored research.

The paper reports theoretical and experimental studies of the use of different types of flat reflective surfaces to increase the collection of solar energy by flat collectors. Specular, diffuse, and combination specular/diffuse reflective surfaces are discussed. The reflectivity properties of a given surface are measured as a function of incident and reflected angles, and on the basis of these measurements the computer model predicts the increase in collector performance with such a reflector. Calculated and experimental results are compared. M.L.

**A79-21167** Diffuse solar radiation on a horizontal surface for a clear sky. R. O. Buckius and R. King (Illinois, University, Urbana, Ill.). *Solar Energy*, vol. 21, no. 6, 1978, p. 503-509, 24 refs. Research supported by the University of Illinois.

**A79-21168** Comparison of transient heat transfer models for flat plate collectors. N. E. Wijesundera (University of Sri Lanka, Peradeniya, Sri Lanka). *Solar Energy*, vol. 21, no. 6, 1978, p. 517-521.

**A79-21169** Energy storage using the reversible oxidation of barium oxide. R. G. Bowrey and J. Jutsen (New South Wales, University, Kensington, Australia). *Solar Energy*, vol. 21, no. 6, 1978, p. 523-525, 8 refs.

The thermodynamics of the BaO/BaO<sub>2</sub> system are surveyed, and three experiments involving BaO powder heated in electric furnaces were performed to study the practicality of the BaO/BaO<sub>2</sub> system for storing energy. It is concluded that the system is practical. Air can be used during both the oxidizing and the reducing steps as the heat transfer fluid and as either the oxygen source or the purging fluid. Suitable conditions for mass transfer are indicated. M.L.

**A79-21171** The application of thermography to large arrays of solar energy collectors. R. G. Mansfield and A. Eden (USAF, Dept. of Civil Engineering, Engineering Mechanics and Materials, Colorado Springs, Colo.). *Solar Energy*, vol. 21, no. 6, 1978, p. 533-537, 10 refs.

The paper describes the use of thermography to predict and observe flow problems within a large solar collector array. Application of thermography requires attention to wind velocity, ambient temperature, and reflected glare. It was found that thermographs represent a qualitative temperature distribution on absorption surfaces even though it is temperatures from the glass collectors

which are measured. Application of an infrared telephoto lens and cathode-ray tube to array maintenance, problem detection, and the study of the effects of flow rates is considered. M.L.

**A79-21249 #** Problems in the development of high-service-life capacitative accumulators (Problemy sozdaniia emkostnykh napitatelei s povyshennym srokom sluzhby). S. L. Zaientz, G. S. Kichaeva, G. S. Kuchinskii, G. G. Lysakovskii, P. G. Popov, V. A. Popova, O. V. Shilin, and G. A. Shneerson. *Akademiia Nauk SSSR, Izvestiia, Energetika i Transport*, Nov.-Dec. 1978, p. 3-8. 13 refs. In Russian.

The paper considers the development of high-power high-service-life pulsed-current generators (capacitative accumulators) used for supplying power to fusion reactors. Such devices are designed for powers of greater than 100 MJ and to perform for lifetimes of approximately 10 to the 8th pulses. Problems associated with the optimization of such devices are discussed. The cost effectiveness of 100-MJ current generators for magnetic-confinement fusion reactors is demonstrated. B.J.

**A79-21259 #** Financial/management scenarios for a satellite power system program. J. P. Vajk, R. D. Stutzke, M. S. Klan (Science Applications, Inc., Pleasanton, Calif.), R. Salkeld, and G. H. Stine. *American Astronautical Society, Anniversary Conference, 25th, Houston, Tex., Oct. 30-Nov. 2, 1978, Paper 78-144*. 48 p. 23 refs. Contract No. EG-77-C-01-4024.

Ten different methods for financing the development of the satellite power system are examined. An analysis of the capital requirements suggests that the initial investment costs may total several tens of billions of dollars prior to return of commercially significant quantities of power. The 10 organizational forms considered involve existing government agencies, new government agency, taxpayer stock corporation, trust fund supported by energy taxes, federal agency supported by floating long-term bonds backed by the Treasury, the staging company concept, a government-chartered monopoly, the consortium model, the corporate socialism model, and the universal capitalism model. M.L.

**A79-21265 #** An evolutionary solar power satellite program. G. M. Hanley and W. R. Rhote (Rockwell International Corp., Satellite Systems Div., Downey, Calif.). *American Astronautical Society, Anniversary Conference, 25th, Houston, Tex., Oct. 30-Nov. 2, 1978, Paper 78-153*. 19 p.

An evolutionary solar power satellite (SPS) development plan was prepared to satisfy stated objectives. In this paper, effort is mainly directed to amplification of the technology advancement phase of the SPS development plan for the projected time frame 1980-1990. The discussion focuses on the microwave exploratory research program, the SPS power conversion/distribution and structures technology, the SPS orbital test platform evolution at low earth orbit and geosynchronous earth orbit, and the pilot plant demonstration phase. A well-focused ground test program supported by key Shuttle sortie experiments during the period 1980-1985 can lead to the evolution of the SPS orbital test platform during the latter part of the decade. Completion of the SPS technology advancement phase of SPS development in 1990 will provide the technical confidence to proceed with the full-scale pilot-plant demonstration phase. S.D.

**A79-21266 #** A development strategy for the solar power satellite. D. L. Gregory (Boeing Aerospace Co., Seattle, Wash.). *American Astronautical Society, Anniversary Conference, 25th, Houston, Tex., Oct. 30-Nov. 2, 1978, Paper 78-154*. 26 p.

An interdisciplinary study examined several problems associated with the solar power satellite (SPS) project, and the number of primary individual shuttle flights required to test the SPS concept is considered. It is suggested that a single sortie for launching a single large aperture satellite should be sufficient for providing proof of SPS concepts. The satellite and its role in studying developmental operations are described. After this project, which could be organized by about 1983, a later project, designed to assure success

of major flight projects, would involve three shuttle flight sorties to study a structural beam 'machine', an orbital work station, and high power elements. M.L.

**A79-21270 \* #** Costing the satellite power system. G. A. Hazelrigg, Jr. (ECON, Inc., Princeton, N.J.). *American Astronautical Society, Anniversary Conference, 25th, Houston, Tex., Oct. 30-Nov. 2, 1978, Paper 78-166*. 23 p. 9 refs. Contract No. NAS8-3302.

The paper presents a methodology for satellite power system costing, places approximate limits on the accuracy possible in cost estimates made at this time, and outlines the use of probabilistic cost information in support of the decision-making process. Reasons for using probabilistic costing or risk analysis procedures instead of standard deterministic costing procedures are considered. Components of cost, costing estimating relationships, grass roots costing, and risk analysis are discussed. Risk analysis using a Monte Carlo simulation model is used to estimate future costs. M.L.

**A79-21273 #** Health maintenance and health surveillance considerations for an SPS space construction base community. J. P. Kornberg, P. K. Chapman, and P. E. Glaser (Arthur D. Little, Inc., Cambridge, Mass.). *American Astronautical Society, Anniversary Conference, 25th, Houston, Tex., Oct. 30-Nov. 2, 1978, Paper 78-176*. 13 p. 5 refs.

Successful development of the solar power satellite (SPS) would remove the limits to growth imposed by nonrenewable terrestrial energy resources. The requirements for the assembly and maintenance of the SPS are investigated. Construction costs, including transportation of the required construction crew of about 550 people and amortization of the bases, are projected to account for about 8% of the total SPS capital cost. The construction crew's primary activity would be monitoring, servicing, and repairing, with little need for extravehicular activities. It is anticipated that the crew will live and work in the SPS space construction base community, which will be capable of supporting all occupational and nonoccupational activities over extended periods. The most important goal to be met at the construction base is to guarantee the maintenance of the good health of the crew. Appropriate health maintenance and health surveillance activities are discussed. G.R.

**A79-21275 #** Future programs and prospects for resource exploration from space by the year 2000. M. T. Halbouty. *American Astronautical Society, Anniversary Conference, 25th, Houston, Tex., Oct. 30-Nov. 2, 1978, Paper 78-182*. 21 p. 6 refs.

It is suggested that a national program should be organized to facilitate exploration of natural resources. The significance of remote sensing data obtained by aircraft and spacecraft is considered, and estimates of potential oil and gas reserves are examined with reference to geopolitics and the transition to the post-petroleum era. The importance of Landsat, which detects landscape lineaments and provides repetitive coverage of the earth's surface, is explained, and extension of remote sensing techniques is discussed. M.L.

**A79-21300 \* #** Thermal storage for industrial process and reject heat. R. A. Duscha and W. J. Masica (NASA, Lewis Research Center, Cleveland, Ohio). *U.S. Department of Energy, Conference on Waste Heat Management and Utilization, 2nd, Miami Beach, Fla., Dec. 4-6, 1978, Paper*. 12 p. 7 refs. Contract No. EC-77-A-31-1034.

Industrial production uses about 40% of the total energy consumed in the United States. The major share of this is derived from fossil fuel. Potential savings of scarce fuel is possible through the use of thermal energy storage (TES) of reject or process heat for subsequent use. Results of study contracts awarded by the Department of Energy (DOE) and managed by the NASA Lewis Research Center have identified three especially significant industries where high temperature TES appears attractive - paper and pulp, iron and steel, and cement. Potential annual fuel savings with large scale implementation of near-term TES systems for these three industries is nearly 9 million bbl of oil. (Author)



**A79-21302 \* #** Microprocessor control of a wind turbine generator. A. J. Gnecco and G. T. Whitehead (NASA, Lewis Research Center, Cleveland, Ohio). *Institute of Electrical and Electronics Engineers, Conference on Industrial Applications of Microprocessors, Philadelphia, Pa., Mar. 20-22, 1978, Paper. 15 p. Contract No. E(49-26)-1028.*

This paper describes a microprocessor based system used to control the unattended operation of a wind turbine generator. The turbine and its microcomputer system are fully described with special emphasis on the wide variety of tasks performed by the microprocessor for the safe and efficient operation of the turbine. The flexibility, cost and reliability of the microprocessor were major factors in its selection. (Author)

**A79-21334** Wind power potential in the Pacific Northwest. R. W. Baker, E. W. Hewson (Oregon State University, Corvallis, Ore.), N. G. Butler, and E. J. Warchol (Bonneville Power Administration, Portland, Ore.). *Journal of Applied Meteorology*, vol. 17, Dec. 1978, p. 1814-1823. 10 refs. Research supported by the Oregon Peoples Utility Districts Directors' Association and Eugene Water and Electric Board; Bonneville Power Administration Grant No. EW-78-C-80-1310.

The location, assessment, and potential of wind power resources in the Pacific Northwest are discussed. For assessment, 33 active data stations, ranging from strip chart recorders to simple wind run recorders, are used in addition to national weather service stations. Areas with proven potential include the coastal zone of Oregon and Washington and the adjoining offshore waters, the Columbia River Gorge and adjacent ridge tops running from central Washington to just east of Portland, and portions of northeastern Nevada. Several other high-elevation areas are thought to have high potential, but winds have not yet been measured. The durations of winds with suitable speeds is examined on a seasonal basis and for different weather conditions. Costs and output of different sizes of wind turbine generators are estimated. M.L.

**A79-21347 \*** Hydrogen enrichment for low-emission jet combustion. R. M. Clayton (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In: *Evaporation-combustion of fuels*. Washington, D.C., American Chemical Society (Advances in Chemistry Series, No. 166), 1978, p. 267-286. 19 refs. Contract No. NAS7-100.

Simultaneous gaseous pollutant emission indexes (g pollutant/kg fuel) for a research combustor with inlet air at 120,900 N/sq m (11.9 atm) pressure and 727 K (849 F) temperature are as low as 1.0 for NO<sub>x</sub> and CO and 0.5 for unburned HC. Emissions data are presented for hydrogen/jet fuel (JP-5) mixes and for jet fuel only for premixed equivalence ratios from lean blowout to 0.65. Minimized emissions were achieved at an equivalence ratio of 0.38 using 10-12 mass percent hydrogen in the total fuel to depress the lean blowout limit. They were not achievable with jet fuel alone because of the onset of lean blowout at an equivalence ratio too high to reduce the NO<sub>x</sub> emission sufficiently. (Author)

**A79-21428** Properties of the plasma ions and the particle lifetime in ohmic heating in the L-2 stellarator. M. S. Berezhtskii, G. S. Voronov, S. E. Grebenshchikov, A. B. Izvozchikov, Iu. I. Nechaev, I. S. Sbitnikova, O. I. Fedianin, Iu. V. Khol'nov, A. V. Khudoleev, and I. S. Shpigel' (Akademiia Nauk SSSR, Fizicheskii Institut, Moscow, USSR). (*Fizika Plazmy*, vol. 4, Mar.-Apr. 1978, p. 251-260.) *Soviet Journal of Plasma Physics*, vol. 4, Mar.-Apr. 1978, p. 138-143. 10 refs. Translation.

Ion temperature is studied as a function of the discharge properties. The energy removed from the ions through charge exchange and the ion energy lifetime are estimated. The lifetime is several times shorter than the neoclassical value. The density of neutral hydrogen in the plasma is determined. The lifetimes of the charged particles are estimated. (Author)

**A79-21429** Effect of the magnetic configuration of the poloidal diverter on the plasma in the T-12 finger-ring tokamak. A.

V. Bortnikov, N. N. Brevnov, S. N. Gerasimov, V. G. Zhukovskii, N. V. Kuznetsov, V. I. Pergament, L. N. Khimchenko (Akademiia Nauk SSSR, Institut Atomnoi Energii, Moscow, USSR), W. C. Guss (Akademiia Nauk SSSR, Institut Atomnoi Energii, Moscow, USSR; General Atomic Co., San Diego, Calif.), and D. P. Hutchinson (Akademiia Nauk SSSR, Institut Atomnoi Energii, Moscow, USSR; Oak Ridge National Laboratory, Oak Ridge, Tenn.). (*Fizika Plazmy*, vol. 4, Mar.-Apr. 1978, p. 261-268.) *Soviet Journal of Plasma Physics*, vol. 4, Mar.-Apr. 1978, p. 144-148. Translation.

Experiments carried out in the T-12 finger-ring tokamak with two poloidal diverters are reported. The purpose of the experiments was to determine how the magnetic configuration of the poloidal diverter affects the physical properties of the plasma, the MHD stability, and the vertical stability. The results show that the configuration has a positive effect on the plasma properties and essentially no effect on MHD processes in the plasma (no effect on the evolution of  $m = 2$  perturbations or on the current disruption). (Author)

**A79-21430** Laser measurements of the radial profiles of the electron temperature and density in the FT-1 tokamak. V. K. Gusev, V. S. Il'in, M. M. Larionov, A. D. Lebedev, L. S. Levin, Iu. K. Mikhailovskii, and G. T. Razdobarin (Akademiia Nauk SSSR, Fiziko-Tekhnicheskii Institut, Leningrad, USSR). (*Fizika Plazmy*, vol. 4, Mar.-Apr. 1978, p. 269-274.) *Soviet Journal of Plasma Physics*, vol. 4, Mar.-Apr. 1978, p. 148-151. 5 refs. Translation.

The radial profiles and time evolution of the electron density and temperature in the FT-1 tokamak have been measured under conditions such that the average electron density in the discharge was  $5 \times 10^{10}$  per cu cm. A ruby laser with a pulse energy of 5 J was used. The observation solid angle was .015 sr. A pulsed multi-channel spectrometer was used to detect the scattered-light spectrum. The radial profiles of the properties were recorded during ohmic heating of the plasma. A change in the profile of the electron temperature was detected when the RF pulse was applied to the plasma. (Author)

**A79-21432** Fast penetration of a magnetic field into a low-density plasma. O. G. Parfenov and A. A. Shishko (Akademiia Nauk SSSR, Institut Zemnogo Magnetizma, Ionosfery i Rasprostraneniia Radiovoln, Irkutsk, USSR). (*Fizika Plazmy*, vol. 4, Mar.-Apr. 1978, p. 297-303.) *Soviet Journal of Plasma Physics*, vol. 4, Mar.-Apr. 1978, p. 165-168. 19 refs. Translation.

Energy transport across a magnetic field is studied experimentally and in a numerical MHD simulation. A self-consistent method for incorporating the results of the theory of plasma turbulence is described. The use of this method to study the formation of the fine structure of the front of a magnetosonic shock wave and the super-Alfven penetration of a nonlinear magnetic perturbation into a low-density plasma is reported. An explanation is found for the basic experimental results obtained previously. Magnetothermal effects play an important role in intense plasma heating. (Author)

**A79-21433** Optimum properties of a noncylindrical pinch. K. G. Gureev (Akademiia Nauk SSSR, Institut Atomnoi Energii, Moscow, USSR). (*Fizika Plazmy*, vol. 4, Mar.-Apr. 1978, p. 304-314.) *Soviet Journal of Plasma Physics*, vol. 4, Mar.-Apr. 1978, p. 169-174. 13 refs. Translation.

The optimum properties of a noncylindrical pinch, for which the useful neutron energy exceeds the energy input, are determined. Two approaches are used to optimize the properties. The first approach is based on a simplified description of the configuration. In this approach, the basic physical properties in the pinch can be related to the parameters of the experimental apparatus analytically, without resorting to numerical calculations. In the second approach, numerical calculations model in detail the physical processes which occur in this system. The optimum properties found and confirmed in this manner differ markedly from those predicted earlier on the basis of empirical relations. (Author)

**A79-21434**      **Structure of the current shell in a Z pinch.** S. I. Ananin, V. V. Vikhrev, and N. V. Filippov (Akademiia Nauk SSSR, Institut Atomnoi Energii, Moscow, USSR). (*Fizika Plazmy*, vol. 4, Mar.-Apr. 1978, p. 315-322.) *Soviet Journal of Plasma Physics*, vol. 4, Mar.-Apr. 1978, p. 175-179. 10 refs. Translation.

The current structure of the plasma shell is studied with magnetic probes and through a numerical simulation of the motion of the shell on the basis of three-fluid hydrodynamics. The good agreement between theory and experiment is evidence that this model correctly describes the processes occurring in the plasma shell of a Z pinch. (Author)

**A79-21443**      **Cyclotron-wave spectrum in a plasma with two ion species.** T. D. Kaladze and L. V. Tsamalashvili (Tbilisskii Gosudarstvennyi Universitet, Tiflis, Georgian SSR). (*Fizika Plazmy*, vol. 4, Mar.-Apr. 1978, p. 394-398.) *Soviet Journal of Plasma Physics*, vol. 4, Mar.-Apr. 1978, p. 222-224. 17 refs. Translation.

The dispersion relation is solved numerically for ion cyclotron waves propagating across the magnetic field in a plasma containing ions of two species (deuterium and tritium) for various ratios of plasma pressure to magnetic pressure. Ion cyclotron wave frequency is examined as a function of wave vector for  $\beta = 1$  and  $\beta = 10$ . The problem is considered with respect to tokamak plasma conditions. B.J.

**A79-21473 #**      **Optimal decisions for long-term operation of hydropower systems.** I. Seteanu and R. Popa (Bucuresti, Institutul Politehnic, Bucharest, Rumania). *Revue Roumaine des Sciences Techniques, Série Electrotechnique et Énergétique*, vol. 23, Oct.-Dec. 1978, p. 489-499.

A dynamic programming model is described and applied to characterize the optimum long-term operation of a large reservoir which is part of a hydropower system. Although the approach is concerned with maximum performance for a period of several years, the results indicate procedures for maximizing the high-likelihood power on an annual basis. In the analysis, the maximum storage capacity is assumed to be 715 million cu m and the monthly average mandatory releases are assumed to be constant for each month. (Author)

**A79-21479**      **Performance of molten salt sodium/beta-alumina/SbCl<sub>3</sub> cells.** A. M. Chreitzberg, J. W. Consolloy, M. R. Manning, and J. C. Sklarчук (ESB Technology Co., Yardley, Pa.). (*International Symposium on Molten Electrolytes and High Temperature Batteries*, Brighton, England, Sept. 22, 23, 1977.) *Journal of Power Sources*, vol. 3, Nov. 1978, p. 201-214. Research sponsored by the Electric Power Research Institute and ESB Ray-O-Vac Corp.

Twenty watt-hour size cells were tested at 180-260 C to observe performance trends as a function of charge and discharge rate, temperature, and cycling on a 3 cycle-per-day routine. Major components of the test geometry were a carbon-steel outer sodium container, a beta alumina separator tube 2.5-cm o.d. by 15 cm long and with a 2 mm thick wall, spiral nickel or molybdenum brush current collectors, and a positive mix of carbon powder, sodium chloroaluminate, and antimony trichloride. Energy input and output, energy efficiency, and antimony utilization were monitored at discharge rates of 3, 5, 7, 10, and 14 hours and charge rates of 3, 5, 7, and 10 hours to 100% depth (4.0 V top of charge and 1.9 V bottom of discharge). Scaled up 50 and 80 Wh cells were constructed and tested. Projections of the performance of 200 Wh cells and the cost of a 100 MWh battery are given for utility load-leveling applications. (Author)

**A79-21480**      **A study of positive electrode materials for batteries operating in a halide-aluminate medium.** S. Măximovitch, M. Levart, M. Foulletier, N. Nguyen, and G. Bronoel (Grenoble, Ecole Nationale Supérieure d'Electrochimie et d'Electrometallurgie, Saint-Martin-d'Hères, Isère, France). *Journal of Power Sources*, vol. 3, Nov. 1978, p. 215-225. 12 refs. Research supported by the Direction des Recherches et d'Etudes Techniques.

Cathode behavior in halide-aluminate media was studied with attention focused on the oxidation and reduction processes of halide compounds. The cathodes were made from different carbon and graphite intercalation compounds. It is found that in chloride medium the reduction of fixed chlorine proceeds via two steps while in a mixed bromide-chloride medium a single reduction wave is observed. All cathode compounds tested showed degradation during charge-discharge cycling; the degradation is caused by a leaching out of intercalated halides. Thus, none of the tested compounds are suitable for secondary batteries. M.L.

**A79-21481**      **Casing materials for sodium/sulfur cells.** B. Hartmann (Brown, Boveri et Cie. AG, Heidelberg, West Germany). (*International Symposium on Molten Electrolytes and High Temperature Batteries*, Brighton, England, Sept. 22, 23, 1977.) *Journal of Power Sources*, vol. 3, Nov. 1978, p. 227-235. 10 refs. Research supported by the Bundesministerium für Forschung und Technologie.

Specifications for suitable casing materials for sodium/sulfur cells are discussed. In order to select the best materials, three types of experiments have been performed: static corrosion tests, experiments which used the samples as electrodes in Na<sub>2</sub>S<sub>4</sub>, and tests in Na/S cells. According to the results of the static corrosion tests the materials are arranged in three groups for practical reasons. Aluminum in contact with Na<sub>2</sub>S<sub>4</sub> at 350 C develops an insulating layer. Corrosion layers formed on heavy metal alloys possess quite high conductivities. The structure of these layers is discussed. As the cell casing serves as a current collector, aluminum was coated with chromium containing iron, cobalt, or nickel alloys. Plasma spraying was used as the coating method. The usefulness of coated aluminum was demonstrated in Na/S cells. (Author)

**A79-21482**      **Influence of composition on the activity of tungsten carbide gas diffusion hydrogen electrodes.** I. Nikolov, L. Grigorov, T. Vitanov (B'lgarska Akademiia na Naukite, Tsentralna Laboratoriia po Elektrokhimichni Iztochnitsi na Tok, Sofia, Bulgaria), M. Svata, and Z. Zabransky (B'lgarska Akademiia na Naukite, Tsentralna Laboratoriia po Elektrokhimichni Iztochnitsi na Tok, Sofia, Bulgaria; Ceskoslovenska Akademie Ved, Ustav Fyzikalni Chemie a Elektrochemie, Prague, Czechoslovakia). *Journal of Power Sources*, vol. 3, Nov. 1978, p. 237-244. 10 refs.

**A79-21483**      **Influence of the electrolyte content of oxygen carbon gas-diffusion electrodes on their electro-chemical performance in acid solutions.** M. Musilova, J. Mrha (Ceskoslovenska Akademie Ved, Ustav Fyzikalni Chemie a Elektrochemie, Prague, Czechoslovakia), A. Kaisheva, I. Iliev, and S. Gamburgzev (Ceskoslovenska Akademie Ved, Ustav Fyzikalni Chemie a Elektrochemie, Prague, Czechoslovakia; B'lgarska Akademiia na Naukite, Tsentralna Laboratoriia po Elektrokhimichni Iztochnitsi na Tok, Sofia, Bulgaria). *Journal of Power Sources*, vol. 3, Nov. 1978, p. 245-255. 7 refs.

**A79-21484**      **Silver selenate and silver tellurate as positive materials for lithium primary power sources.** F. Bonino, C. Forte, M. Lazzari (CNR, Centro di Studio Processi Elettrodici, Milan, Italy), and B. Scrosati (Roma, Università, Rome, Italy). *Journal of Power Sources*, vol. 3, Nov. 1978, p. 257-265. 20 refs. Research supported by the Consiglio Nazionale delle Ricerche.

The performances of button-type lithium cells based on Ag<sub>2</sub>SeO<sub>4</sub> and Ag<sub>2</sub>TeO<sub>4</sub> as cathodes have been determined in various organic electrolytes. These silver salts present relevant energetic properties and may be considered as interesting cathodic materials for application in primary lithium power sources. Information on the discharge processes has also been obtained by determining the electrode utilization at low rates and by X-ray analyses of the discharge products. Finally, Ag<sub>2</sub>SO<sub>4</sub> has been examined also as a cathode material in lithium cells. However, its performance was rather poor, probably because of a slight solubility in the electrolyte media considered. (Author)

**A79-21485** Effect of electrolyte impurity on the electrochemical performance of the lead/tetrafluoroboric acid/lead dioxide cell. J. E. Curtis and T. J. Sinclair (Royal Armament Research and Development Establishment, Fort Halstead, Kent, England). *Journal of Power Sources*, vol. 3, Nov. 1978, p. 267-276. 11 refs.

**A79-21486** Energy storage requirements for spacecraft. M. G. Gandel (Lockheed Missiles and Space Co., Inc., Space Systems Div., Sunnyvale, Calif.). *Journal of Power Sources*, vol. 3, Nov. 1978, p. 277-289.

Spacecraft electrical power requirements are analyzed, and the constraints posed by these requirements on choice of prime power source and energy storage devices are examined. Characteristics of some electrical system power and storage devices are surveyed, and procedures for matching requirements with element and system properties are considered. Attention is directed to the use of batteries as energy storage devices. M.L.

**A79-21487** Differential scanning calorimetry studies of possible explosion-causing mixtures in Li/SO<sub>2</sub> cells. W. P. Kilroy and S. Dallek (U.S. Navy, Naval Surface Weapons Center, Silver Spring, Md.). *Journal of Power Sources*, vol. 3, Nov. 1978, p. 291-295. 6 refs. Navy-supported research.

The reported qualitative study of exothermic reactions occurring among Li/SO<sub>2</sub> cell components and/or products of discharge is restricted to chemical combinations involving the lithium anode material. Differential scanning calorimetry data and curves are presented. Attention is focused on systems containing lithium and sulfur, lithium and LiAsF<sub>6</sub>, lithium and Li<sub>2</sub>S<sub>2</sub>O<sub>3</sub>, lithium and Teflon, and lithium and LiAsF<sub>6</sub>.4CH<sub>3</sub>CN. M.L.

**A79-21488** Recent advances in Na/S cell development - A review. W. Fischer, W. Haar, B. Hartmann, H. Meinhold, and G. Weddigen (Brown, Boveri et Cie. AG, Heidelberg, West Germany). *Journal of Power Sources*, vol. 3, Dec. 1978, p. 299-309. 31 refs. Research supported by the Bundesministerium für Forschung und Technologie.

This paper describes recent progress in the development of sodium/sulfur batteries. Ceramic beta alumina electrolyte tubes with high conductivity and long life are being fabricated. Sulfur utilization is increased to 80%. Improvements are outlined which have been made in finding corrosion resistant casing materials and in cell design. Experimental cells with a weight of 1.1 kg and a capacity of 90 Wh have been built and successfully tested. Ninety-six of these cells have been electrically connected and enclosed in a conventional thermal insulation. The energy density of this nonoptimized battery was 36 Wh/kg at the 2.5 hour discharge rate. Optimization with respect to weight will result in batteries with an energy density of more than 100 Wh/kg. Further improvements in cycle life are necessary for the practical application of these batteries. (Author)

**A79-21489** Mathematics of coiling in cylindrical electrochemical cells - The theory of a spiral bounded by two circles and its application to the spiral-wound nickel-cadmium cell. W. C. Maskell (Berec Group, Ltd., London, England). *Journal of Power Sources*, vol. 3, Dec. 1978, p. 311-329.

**A79-21490** Economic prospects for the application of new electric energy storage devices. W. Fischer, H. B. Gels, F. Gross, K. Liemert, and F. J. Rohr (Brown, Boveri et Cie. AG, Heidelberg, West Germany). *Journal of Power Sources*, vol. 3, Dec. 1978, p. 331-345. 47 refs.

The technical and economic properties of new storage devices for electric energy such as batteries, hydrogen storage systems, flywheels, steam storage plants and compressed air storage facilities are compared with conventional peak power plants such as gas turbines and hydroelectric storage systems. The analysis shows that batteries, steam storage plants and compressed air storage facilities may be economically competitive with conventional peak power devices. Batteries are especially appropriate for dispersed energy

storage systems. Utilization of storage devices instead of gas turbines results in substitution of oil or natural gas by coal or nuclear fuel.

(Author)

**A79-21491** On the possibility of using silver salts other than Ag<sub>2</sub>CrO<sub>4</sub> in organic lithium cells. P. Cignini, M. Icovi, S. Panero, and G. Pistoia (Roma, Università, Rome, Italy). *Journal of Power Sources*, vol. 3, Dec. 1978, p. 347-357. 23 refs. Research supported by the Consiglio Nazionale delle Ricerche.

Several silver salts, including compounds listed in the literature and new compounds, have been examined to ascertain if their performances as cathodes for lithium cells could exceed that of Ag<sub>2</sub>CrO<sub>4</sub>. Discharges at various rates, polarization and cyclic voltammetry experiments were used to characterize their behavior. Coulombic and X-ray analysis have enabled information to be obtained on the discharge reactions but the reductions of the anions still have uncertain features. Of the compounds examined, Ag<sub>4</sub>P<sub>2</sub>O<sub>7</sub> is the most promising one, especially by virtue of a higher load voltage. Ag<sub>5</sub>IO<sub>6</sub> and AgIO<sub>3</sub>, at low rates, and AgIO<sub>4</sub>, at high rates, also approach the performance of Ag<sub>2</sub>CrO<sub>4</sub>. (Author)

**A79-21532** # Investigation of the Hall effect in a discharge with a rotational electric field (Issledovanie effekta Kholla v razriade s vikhrevym elektricheskim polem). A. P. Zhilinskii, B. V. Kuteev, A. S. Smirnov, and R. Sh. Tukhvatulin (Leningradskii Politekhnikeskii Institut, Leningrad, USSR). *Zhurnal Tekhnicheskoi Fiziki*, vol. 48, Oct. 1978, p. 2044-2046. In Russian.

It is shown experimentally that large values of the Hall parameter can be obtained in an electrodeless dc discharge. In this case, the plasma, formed directly in the magnetic field, was quasi-stationary. Measurements were carried out always in the active stage of the discharge, so that the influence of plasma decay on the measurement of the effective Hall parameter was eliminated. V.P.

**A79-21538** # Turbulence of a combustion product plasma in an MHD channel (O turbulentnosti plazmy produktov sgoraniia v MGD kanale). A. I. Bystryi, R. V. Ganefel'd, and V. B. Red'kin (Akademiia Nauk Ukrainskoi SSR, Institut Elektrodinamiki, Kiev, Ukrainian SSR). *Zhurnal Tekhnicheskoi Fiziki*, vol. 48, Oct. 1978, p. 2074-2079. 6 refs. In Russian.

In the experiment described, the level and scale of turbulence and its correlation and spectral characteristics were studied for a combustion product plasma in an MHD channel. The manner in which the magnetic and electric fields affect the turbulence structure is illustrated. V.P.

**A79-21542** # Contribution to the theory of the pulsed mode of operation of the thermionic energy converter. II (K teorii impul'snogo rezhima termoemissionnogo preobrazovatel'ia energii. II). V. A. Zharebtsov and V. D. Talanova. *Zhurnal Tekhnicheskoi Fiziki*, vol. 48, Oct. 1978, p. 2103-2112. 11 refs. In Russian.

The ionization process occurring in a thermionic energy converter operating in the pulsed mode is analyzed in the case where a negative voltage pulse is applied to the anode. In the case of a one-component filling of the diode, ions are produced in the anode sheath. This impairs considerably the effectiveness of their utilization during the plasma decay stage. When the diode is filled with heavy inert gases, the energy losses by ion production are as high as 60 eV. In the case of a two-component filling, the ionization region widens while the energy losses by ion production are reduced. V.P.

**A79-21585** # Experimental study of the characteristics of heat and mass transfer in a two-component low-temperature heat pipe (Eksperimental'noe izuchenie osobennosti teplo- i massoobmena v dvukhkomponentnoi nizkotemperaturnoi teplovoi trube). Ia. M. Baum, V. P. Sorokin, and S. S. Iurov. *Inzhenerno-Fizicheskii Zhurnal*, vol. 35, Dec. 1978, p. 1034-1043. 11 refs. In Russian.

Experimental results are presented on a heat pipe with varying component concentrations of the heat-carrying fluid, a mixture of

water and ethanol. A qualitative model is presented for the mechanism of mass transfer in the evaporator; according to the model the mean-mass concentration of components in each cross section is determined by the interaction of vapor flows. It is found that the maximum power of a two-component pipe significantly exceeds that of a pipe with ethanol alone as the heat-carrying fluid. Neither the transferred power nor the intensity of evaporation and condensation has a significant effect on the degree of component separation in the heat pipe. B.J.

**A79-21626** Nonstationary two-dimensional magnetohydrodynamic flow in a radial channel. N. P. Gridnev and S. S. Katsnel'son. (*Magnitnaia Gidrodinamika*, Apr.-June 1978, p. 77-82.) *Magnetohydrodynamics*, vol. 14, no. 2, Dec. 1978, p. 200-205. 9 refs. Translation.

The present analysis deals with the situation where the flow generated in a cylindrical tube by the passage of a shock wave through an inert gas with an alkali metal addition issues into a disk-shaped MHD channel. The complex interaction of the expanding plasma flow with the magnetic field is analyzed, and a finite-difference scheme of third order accuracy, with a uniform time step, is proposed for calculating the shock interactions. For illustration, the flow is calculated for conditions where both the magnetic Reynolds number and the Hall parameter are small. V.P.

**A79-21627** Accounting for the effect of a yoke in an MHD linear induction machine by stipulating boundary conditions of a new kind. A. Ia. Vilnitis. (*Magnitnaia Gidrodinamika*, Apr.-June 1978, p. 87-96.) *Magnetohydrodynamics*, vol. 14, no. 2, Dec. 1978, p. 210-219. 19 refs. Translation.

In the present paper, the action of the magnetic yoke of a linear MHD-machine is expressed by introducing a new type of boundary conditions in the form of a stepped normal induction component. This, together with the passage to a 'thin' working fluid at the limit, makes it possible to reduce the regions of both the working fluid and the yoke to lines (traces) with specified boundary conditions, assuming all the while that the Laplace equation is satisfied everywhere else. The new boundary conditions can be obtained by Fourier transforms with respect to the longitudinal coordinate. For an infinite yoke, the solution is shown to be rational. The case of a finite yoke leads to an integral equation or to an infinite system of algebraic equations. V.P.

**A79-21628** Optimization of a diagonal MHD channel. D. A. But, I. I. Doperchuk, and S. M.-A. Koneev. (*Magnitnaia Gidrodinamika*, Apr.-June 1978, p. 110-116.) *Magnetohydrodynamics*, vol. 14, no. 2, Dec. 1978, p. 231-237. 13 refs. Translation.

In the present paper, a diagonal MHD-channel is optimized with allowance for transient turbulent boundary layers and boundary layer separation, placing constraints on the channel geometry, the magnetic field, and some other parameters of the problem. Optimization is achieved by a nonlinear programming method, termed the method of moving tolerances, modified to improve the convergence of the iterations. It is shown that the value of the conversion coefficient can be increased by 10 to 12% by rational profiling of the channel and electrode walls. V.P.

**A79-21667** Experimental investigations of a physical system capable of using solar energy. R. Rup (Delhi, University, Delhi, India). *Journal of Physics D - Applied Physics*, vol. 11, Dec. 21, 1978, p. L207-L209.

A simple low-cost physical system capable of working at low temperature differences can be used profitably with a flat-plate solar collector. One such system, reported by West (1974), uses regenerative oscillations set up in the water columns in the three limbs of the system which presumably uses a Stirling cycle with air as the working fluid. Preliminary experiments were carried out which showed that,

for low temperature differences of the working fluid on either side of the regenerator, water vapor in the working fluid played an important role. Subsequently, a simple theoretical model was used to work out the dynamics of the system with two working fluids - dry air (dry system) and air saturated with water vapor (wet system). The present report shows that there is good agreement between theoretical and experimental results for both the dry and wet system. B.J.

**A79-21676** Hydrides for energy storage; Proceedings of the International Symposium, Geilo, Norway, August 14-19, 1977. Symposium sponsored by the Institutt for Atomenergi and Allied Chemical Corp. Edited by A. F. Anderson (Institutt for Atomenergi, Kjeller, Norway) and A. J. Maeland (Allied Chemical Corp., Morristown, N.J.). Oxford, Pergamon Press, Ltd., 1978. 611 p. \$60.

Consideration is given to the prospects of hydrogen as an energy carrier for the future, structure and bonding in metal hydrides, the nature of He-3 confinement in transition metal hydrides, hydrogen adsorption in rare earth intermetallic compounds, and the use of FeTi-hydrides for production and storage of suprapure hydrogen. Papers are also presented on such topics as hysteresis effects in metal-hydrogen systems, electrochemical utilization of metal hydrides, hydrogen storage electrode systems, the hydrogen/hydride energy concept, and the metallurgy and production of rechargeable hydrides. B.J.

**A79-21677** The prospects of hydrogen as an energy carrier for the future. G. G. Libowitz (Allied Chemical Corp., Morristown, N.J.). In: Hydrides for energy storage; Proceedings of the International Symposium, Geilo, Norway, August 14-19, 1977.

Oxford, Pergamon Press, Ltd., 1978, p. 1-17. 36 refs.

An indication of some of the scientific problems and possible solutions associated with the development of a hydrogen economy is presented. Emphasis is on materials problems which may be associated with the generation, utilization, and transmission and storage of hydrogen. This includes a discussion of such topics as catalysis, solid state electrolysis, photoelectrolysis, thermochemical generation of hydrogen, and metal-hydrogen interactions. B.J.

**A79-21678** Survey of the different types of hydrides. A. J. Maeland (Allied Chemical Corp., Morristown, N.J.). In: Hydrides for energy storage; Proceedings of the International Symposium, Geilo, Norway, August 14-19, 1977. Oxford, Pergamon Press, Ltd., 1978, p. 19-31. 35 refs.

Binary hydrides, classified according to bonding as saline, metallic, and covalent, are reviewed with respect to structure and thermodynamic properties. Hydrides of intermetallic compounds (considered as pseudo-binary hydrides) are included in the survey. Pressure-composition isotherms are presented for metal-hydrogen systems. The study has relevance to hydrogen energy development. B.J.

**A79-21679** Structure and bonding in metal hydrides. W. E. Wallace and S. K. Malik (Pittsburgh, University, Pittsburgh, Pa.). In: Hydrides for energy storage; Proceedings of the International Symposium, Geilo, Norway, August 14-19, 1977.

Oxford, Pergamon Press, Ltd., 1978, p. 33-42. 23 refs. Research supported by the Petroleum Research Fund.

Bonding in hydrides of alkali metals, alkaline earth metals and of Eu and Yb is essentially ionic in nature and hydrogen in these materials is anionic. This is indicated by the structures, stoichiometries, and lattice energies of these hydrides. Recent work on the band structure of transition metal hydrides indicates that the simple protonic model is incorrect. Hydrogen participates, along with the ion cores of the host metal, in establishing the potential within which the delocalized electrons move. Hydrogen contributes states as well as electrons, in contrast to its behavior in the protonic model, where it contributes only electrons. Special complexities which can arise for substoichiometric hydrides are illustrated by reference to the Ta<sub>2</sub>H system. B.J.

**A79-21680** Thermodynamics of metal, alloy and intermetallic/hydrogen systems. T. B. Flanagan (Vermont, University, Burlington, Vt.). In: Hydrides for energy storage; Proceedings of the International Symposium, Geilo, Norway, August 14-19, 1977.

Oxford, Pergamon Press, Ltd., 1978, p. 43-59.

39 refs. NSF-supported research.

The thermodynamics of solution of hydrogen in metals (alloys or intermetallics) is reviewed for single phase regions of solubility. Consideration is given to the conversion of experimental data from conditions of essentially constant pressure to conditions of constant volume. The fundamental significance of thermodynamic parameters obtained from the temperature dependence of the two-phase coexistence pressures is examined and the necessary criteria for which these values correspond to the thermodynamics of the reaction  $1/2H_2(g) + M(H\text{-saturated})$  yields metal hydride are developed. Some experimental methods are reviewed. B.J.

**A79-21681** Structural studies of hydrides by neutron diffraction. A. F. Andresen (Institutt for Atomenergi, Kjeller, Norway). In: Hydrides for energy storage; Proceedings of the International Symposium, Geilo, Norway, August 14-19, 1977.

Oxford, Pergamon Press, Ltd., 1978, p. 61-72.

15 refs.

The application of neutron diffraction to the study of hydride structures is reviewed. Particular consideration is given to powder neutron diffraction, difficulties associated with the neutron diffraction investigation of hydrides, and some special applications of this technique. Emphasis is placed on some of the hydrides which are of interest for energy storage, including  $CaH_2$  and La-Ni hydrides. B.J.

**A79-21682** Localization and diffusion of hydrogen in lanthanum-nickel compounds. A. Furrer, P. Fischer, W. Halg (Eidgenössische Technische Hochschule, Würenlingen, Switzerland), and L. Schlappbach (Eidgenössische Technische Hochschule, Zurich, Switzerland). In: Hydrides for energy storage; Proceedings of the International Symposium, Geilo, Norway, August 14-19, 1977.

Oxford, Pergamon Press, Ltd., 1978, p. 73-82. 11 refs.

The static and dynamic properties of hydrogen in La-Ni compounds with different hydrogen contents have been studied by means of thermal neutron scattering. The hydrogen positions as well as the occupation numbers of the hydrogen sites in  $LaNi_5H(x)$  and  $La_7Ni_3H(x)$  have been determined by neutron diffraction using deuterated samples. The neutron inelastic scattering technique has been used to study the hydrogen diffusion process in  $LaNi_5H(x)$  by observing the width of the quasi-elastic line as a function of momentum transfer. The results are in qualitative agreement with the predictions of a jump diffusion model, and the diffusion parameters are correlated to the structure information obtained from the present neutron diffraction experiments. (Author)

**A79-21683** Nuclear magnetic resonance studies of metal hydrides. B. Pedersen (Norges Teknisk-Naturvitenskapelige Forskningsrad, Sentralinstitutt for Industriell Forskning; Oslo, Universitetet, Oslo, Norway). In: Hydrides for energy storage; Proceedings of the International Symposium, Geilo, Norway, August 14-19, 1977.

Oxford, Pergamon Press, Ltd., 1978, p. 83-95.

26 refs.

Low temperature proton spectra give information on the crystal structure of metal hydrides. At higher temperatures, the proton spectrum is narrowed by hydrogen self-diffusion in all hydrides studied. Both the mean lifetime of a hydrogen atom in a site and the mean distance a hydrogen atom jumps can be determined by NMR spectroscopy, giving detailed information on the diffusion process. Observed shifts of the proton resonance frequency and the meta resonance frequency give information on the electron structure. B.J.

**A79-21684** NMR studies of hydrogen relaxation and diffusion in  $TiFeH_x$  and  $TiFe_{1-y}Mn_yH_x$ . R. C. Bowman, Jr., A. Attalla (Monsanto Research Corp., Miamisburg, Ohio), G. C. Carter (National Bureau of Standards, Institute for Materials Re-

search, Gaithersburg, Md.), and Y. Chabre (Grenoble I, Université, Grenoble, France). In: Hydrides for energy storage; Proceedings of the International Symposium, Geilo, Norway, August 14-19, 1977.

Oxford, Pergamon Press, Ltd., 1978, p. 97-118.

24 refs. Army-supported research; Contract No. EY-76-C-04-0053.

Various NMR parameters were measured in the hydride phase produced for  $TiFe$  and  $TiFe_{0.79}Mn_{0.15}$ . At low temperatures, interactions with conduction electrons dominate proton spin-lattice relaxation times for both beta and gamma phases. Spin echo measurements on beta-phase samples showed motional narrowing above 360 K and yielded a diffusion activation energy of 0.26(2) eV. Hydrogen diffusion in the gamma phase is observed to be slower and an approximate activation energy of 0.80(5) eV is deduced from relaxation time measurements. B.J.

**A79-21685** Electronic structure and physical properties of Ti-H and Zr-H using NMR. C. Korn (Negev, University, Beersheba, Israel). In: Hydrides for energy storage; Proceedings of the International Symposium, Geilo, Norway, August 14-19, 1977.

Oxford, Pergamon Press, Ltd., 1978, p. 119-122.

The spin lattice relaxation time of hydrogen in Zr-H was measured at room temperature as a function of hydrogen concentration in the x range of 1.54-2.00, where x is the atomic hydrogen to zirconium ratio.  $(T_1T)$  exp  $-1/2$ , a measure of the density of states at the Fermi level, shows a sharp peak at  $x = 1.8$  (similar to that found for Ti-H) and a discontinuity at  $x = 1.65$ . The concentration dependence of  $(T_1T)$  exp  $-1/2$  is compared for the Ti-H and Zr-H systems and discussed in the light of a model for hydride electronic structure. The present measurements support the prediction of increased band splitting for Zr-H as proposed in the model. B.J.

**A79-21686** Electronic states of concentrated Pd-H alloys from de Haas-van Alphen measurements. R. Griessen, W. J. Venema (Amsterdam, Vrije Universiteit, Amsterdam, Netherlands), J. K. Jacobs, and F. D. Manchester (Toronto, University, Toronto, Canada). In: Hydrides for energy storage; Proceedings of the International Symposium, Geilo, Norway, August 14-19, 1977.

Oxford, Pergamon Press, Ltd., 1978, p. 123-127.

14 refs.

Results are presented on de Haas-van Alphen measurements on Pd-H alloys, with hydrogen concentrations up to 30 at% H in Pd. It is found that for H/Pd not greater than 0.06 the hydride remains in the alpha phase. The observed decrease in the area of various extremal cross sections of the d-hole ellipsoids at X and L is found to be due entirely to the lattice expansion caused by the interstitial hydrogen and not to the added hydrogen electrons. For H/Pd not less than 0.07 the alloy cannot be quenched in a metastable single phase state; this leads to a sharp drop in the Dingle temperature at H/Pd approximately equal to 0.07. Both the Dingle temperature and the dHvA frequencies remain approximately constant at higher hydrogen concentrations. B.J.

**A79-21687** Kinetics of hydrogen absorption and desorption. T. B. Flanagan (Vermont, University, Burlington, Vt.). In: Hydrides for energy storage; Proceedings of the International Symposium, Geilo, Norway, August 14-19, 1977.

Oxford, Pergamon Press, Ltd., 1978, p. 135-150. 40

refs. NSF-supported research.

Possible slow steps for hydrogen absorption (desorption) by metals, alloys and intermetallics are considered. The sequence of steps for hydrogen solution are: mass transport of  $H_2$ , dissociative chemisorption, surface migration, the transition from the chemisorbed to absorbed state, and bulk diffusion. When two solid phases coexist, the hydride phase transformation must appear in the sequence of steps. It is assumed that reaction occurs under isothermal conditions so that heat transfer can be neglected. For samples in the form of sheets, wires, etc., the slow step is often surface-control but for dispersed samples, such as activated intermetallics, where the rates may be extremely rapid, consideration must be given to mass transport control. The kinetics of hydrogen

absorption (desorption) by activated LaNi<sub>5</sub> are used to illustrate some of these considerations. (Author)

**A79-21688** The storage and release of hydrogen from magnesium alloy hydrides for vehicular applications. D. L. Douglass (California, University, Los Angeles, Calif.). In: Hydrides for energy storage; Proceedings of the International Symposium, Geilo, Norway, August 14-19, 1977. Oxford, Pergamon Press, Ltd., 1978, p. 151-184. 8 refs. Contract No. E(04-3)-34-PA-236.

The optimum hydride for onboard vehicular storage of hydrogen depends on various parameters, such as rapid discharge kinetics at a temperature low enough to use exhaust-gas waste heat (about 220-250 C), a high hydrogen density to minimize the carrier weight, and resistance to fragmentation. Magnesium alloys exhibit some outstanding features but are deficient in other features. The present research program involved the study of numerous alloying additions, single-phase versus two-phase alloys, and binary versus ternary alloys in order to find the optimum alloy for hydrogen storage. The best alloy studied was the ternary Mg-5Ni-5Y which released over 3% hydrogen in 4 hours at 250 C. This alloy came the closest to fulfilling the program objectives and is a viable storage medium for vehicular applications. B.J.

**A79-21689** High temperature thermodynamics of the solid solutions of hydrogen and deuterium in palladium and in the Pd<sub>0.9</sub>Ag<sub>0.1</sub> alloy. G. Boureau and O. J. Kleppa (Chicago, University, Chicago, Ill.). In: Hydrides for energy storage; Proceedings of the International Symposium, Geilo, Norway, August 14-19, 1977. Oxford, Pergamon Press, Ltd., 1978, p. 185-191. 35 refs. NSF Grant No. DMR-75-08175.

**A79-21690** Calculated heats of formation of metal and metal alloy hydrides. C. D. Gelatt (Harvard University, Cambridge, Mass.). In: Hydrides for energy storage; Proceedings of the International Symposium, Geilo, Norway, August 14-19, 1977. Oxford, Pergamon Press, Ltd., 1978, p. 193-204. 25 refs. NSF Grants No. DMR-72-02977; No. DMR-76-01111.

The basic features of the electronic structure of transition metal hydrides are understood. Results of the first ab initio calculation of the trends of the heat of formation of transition metal hydrides are discussed, and the basic one-electron energy difference technique is extended to consider the heat of formation of TiFeH<sub>2</sub> and TiPdH<sub>2</sub>. The present calculational method may be useful in suggesting practical hydrogen storage media, but the accuracy is not sufficiently high that one can quantitatively predict the heat of formation. For more precise results it will be necessary to carry out calculations which include the effects of charge self-consistency, which are treated in the present method by perturbation theory. (Author)

**A79-21691** Acoustic emissions during hydride formation. C. J. M. Northrup, W. J. Kass, and A. G. Beattie (Sandia Laboratories, Albuquerque, N. Mex.). In: Hydrides for energy storage; Proceedings of the International Symposium, Geilo, Norway, August 14-19, 1977. Oxford, Pergamon Press, Ltd., 1978, p. 205-216. 15 refs. ERDA-supported research.

When a metal or alloy forms a hydride, the phase change is usually accompanied by the release of acoustic energy. The density changes that accompany hydride formation may also produce cracking and flaking. The acoustic emission accompanying these processes has been used to follow hydriding reactions and the technique has proven to be sensitive in the detection of boundaries on phase diagrams. Acoustic emission has been used to survey the hydriding properties of a number of alloys and metals (FeTi, LaNi<sub>5</sub>, UAl<sub>2</sub>, and Nb). This technique has proven useful as a method for monitoring particle breakup and for identifying laboratory procedures necessary to activate the hydride. (Author)

**A79-21692** Magnetic and electrical properties of rare earth and rare earth intermetallic hydrides. W. E. Wallace (Pittsburgh,

University, Pittsburgh, Pa.). In: Hydrides for energy storage; Proceedings of the International Symposium, Geilo, Norway, August 14-19, 1977. Oxford, Pergamon Press, Ltd., 1978, p. 217-233. 42 refs. Army-supported research.

The rare earths and chemically related Y and Sc have a strong affinity for hydrogen. This affinity carries over to rare earth intermetallic compounds and is responsible for their exceptional capacity to store hydrogen. The present paper examines the electrical conductivity and magnetic behavior of rare earth hydrides. This examination is used to draw conclusions about the nature of hydrogen in such materials and about the mechanism by which the rare earths interact magnetically in the elemental state. In addition, the influence of hydrogenation on the magnetic behavior of a few selected intermetallics (e.g., GdNi<sub>2</sub>, Y<sub>6</sub>Mn<sub>23</sub> and Th<sub>6</sub>Mn<sub>23</sub>) is presented. B.J.

**A79-21693** Hydrogen absorption in rare earth intermetallic compounds. K. H. J. Buschow and A. R. Miedema (Philips' Gloeilampenfabrieken, Philips Research Laboratories, Eindhoven, Netherlands). In: Hydrides for energy storage; Proceedings of the International Symposium, Geilo, Norway, August 14-19, 1977. Oxford, Pergamon Press, Ltd., 1978, p. 235-249. 27 refs.

The paper examines various rare earth intermetallic compounds which are capable of adsorbing large quantities of hydrogen. Experimental data are discussed in relation to a model which predicts hydrogen adsorption behavior on the basis of stabilities of uncharged intermetallic compounds and corresponding binary rare earth hydrides. Experimental results show that hydrogen adsorption sometimes leads to phase separation or microprecipitation of the binary hydride. The importance of this effect in applications involving continuous H<sub>2</sub> adsorption and desorption cycles is discussed. B.J.

**A79-21694** Some applications of LaNi<sub>5</sub>-type hydrides. H. H. van Mal and A. R. Miedema (Philips' Gloeilampenfabrieken, Philips Research Laboratories, Eindhoven, Netherlands). In: Hydrides for energy storage; Proceedings of the International Symposium, Geilo, Norway, August 14-19, 1977. Oxford, Pergamon Press, Ltd., 1978, p. 251-260. 6 refs.

One consequence of a model for predicting the enthalpy of formation of ternary hydrides is that special compounds that suit the requirements set by a particular technical application can be prepared. The usefulness of metal hydrides in a number of small-scale applications (i.e., other than as a mass storage or transport medium for hydrogen) has already been demonstrated. The present paper discusses in detail such small-scale applications of ternary hydrides (particularly LaNi<sub>5</sub> hydride) in a thermally driven heat pump and a thermal compressor for hydrogen gas. B.J.

**A79-21695** Metal hydride electrodes for electrochemical energy storage. M. H. J. van Rijswijk (Philips' Gloeilampenfabrieken, Philips Research Laboratories, Eindhoven, Netherlands). In: Hydrides for energy storage; Proceedings of the International Symposium, Geilo, Norway, August 14-19, 1977. Oxford, Pergamon Press, Ltd., 1978, p. 261-271. 13 refs.

The paper discusses the characteristic features of hydrogen-absorbing alloys suitable as electrodes in aqueous solutions for the combined evolution, storage, and oxidation of hydrogen. The choice of intermetallics appears to be confined to those in which the major component is thermodynamically stable against oxidation in the hydrogen potential range (i.e., Ni and the noble metals). The capacity of known metal hydride electrodes (LaNi<sub>5</sub>, LaNi<sub>4</sub>Cu, and LaNi<sub>4</sub>Cr) at various temperatures is compared to that of other storage electrodes. It is found that for small particles charge transfer is the main rate-determining step, while for large particles hydrogen transport is the main rate-determining step. B.J.

**A79-21697** Hydrides of rare earth-nickel compounds - Structure and formation enthalpies. G. Busch, L. Schlapbach, and T. von Waldkirch (Eidgenössische Technische Hochschule, Zurich, Switzerland). In: Hydrides for energy storage; Proceedings of the International Symposium, Geilo, Norway, August 14-19, 1977. Oxford, Pergamon Press, Ltd., 1978, p. 287-292.

13 refs.

Investigations on the hydriding characteristics of  $\text{La}_7\text{Ni}_3$ ,  $\text{LaNi}$  and  $\text{Ce}_7\text{Ni}_3$  show that these compounds readily absorb hydrogen up to compositions of  $\text{La}_7\text{Ni}_3\text{H}_{19.3}$ ,  $\text{LaNiH}_{3.85}$  and  $\text{Ce}_7\text{Ni}_3\text{H}_{19.2}$ . From structural and magnetic investigations  $\text{La}_7\text{Ni}_3$  is found to decompose into  $\text{LaH}_3$  and  $\text{LaNi}_5$  on hydrogenation. On desorption at elevated temperatures the original structure is reformed. The enthalpies of formation  $\Delta H$  have been measured for the La-Ni compounds.  $\Delta H$  varies linearly with the La-Ni-composition over the full range 100% La to 100% Ni. This, together with the linear dependence of the hydrogen to metal ratio versus composition shows that the hydrogen uptake of La-Ni-compounds is mainly determined by the enthalpies of formation rather than by the structure. (Author)

**A79-21698** The plateau pressure of RE  $\text{Ni}_5$  and RE  $\text{Co}_5$  hydrides. G. Busch, L. Schlapbach, and A. Seiler (Eidgenössische Technische Hochschule, Zurich, Switzerland). In: Hydrides for energy storage; Proceedings of the International Symposium, Geilo, Norway, August 14-19, 1977. Oxford, Pergamon Press, Ltd., 1978, p. 293-299. 10 refs.

$\text{RENi}_5$  and  $\text{RECo}_5$  compounds (RE stands for rare-earth metal) are known to absorb hydrogen, however, the quantity of hydrogen and the plateau pressure required for hydride formation are not known. In the present paper it is shown that, in the first approximation, the plateau pressure varies exponentially with the unit cell volume of the unhydrided compound. The plateau pressure of other series of hydrides of intermetallic compounds can be described by the same law, substituting the proper values of the constants. This law, however, does not describe all the aspects of the problem. The plateau pressure cannot be explained by geometrical considerations alone. V.P.

**A79-21699** Synthesis and properties of useful metal hydrides - A review of recent work at Brookhaven National Laboratory. J. J. Reilly (Brookhaven National Laboratory, Upton, N.Y.). In: Hydrides for energy storage; Proceedings of the International Symposium, Geilo, Norway, August 14-19, 1977. Oxford, Pergamon Press, Ltd., 1978, p. 301-322. 22 refs. Contract No. EY-76-C-02-0016.

Intermetallic hydride properties and the application of intermetallic compounds to the storage of hydrogen are discussed. Systems considered include Mg-Cu alloys, Mg-Ni alloys, iron-titanium alloys, and Ti-Cr alloys. Predictive criteria are presented for selecting intermetallic compounds likely to form hydrides and ascertaining certain properties of the hydrides. M.L.

**A79-21700** The use of FeTi-hydride for production and storage of suprapure hydrogen. H. Wenzl and K. H. Klatt (Kernforschungsanlage Jülich GmbH, Institut für Festkörperforschung, Jülich, West Germany). In: Hydrides for energy storage; Proceedings of the International Symposium, Geilo, Norway, August 14-19, 1977. Oxford, Pergamon Press, Ltd., 1978, p. 323-327.

6 refs.

**A79-21701** Hydride formation of C14-type Ti alloy. Y. Machida, T. Yamada, and M. Asanuma (Matsushita Research Institute Tokyo, Inc., Kawasaki, Japan). In: Hydrides for energy storage; Proceedings of the International Symposium, Geilo, Norway, August 14-19, 1977. Oxford, Pergamon Press, Ltd., 1978, p. 329-336. 9 refs.

The paper describes the hydriding properties of the TiCr2-based C14-type quaternary alloy system  $\text{Ti}(1-x)\text{Zr}(x)\text{Cr}(2-y)\text{Mn}(y)$  with  $x$  in the 0-0.5 range and  $y$  in the 0-2 range. The P-X-T method was used to determine some thermodynamic parameters. The Zr content was found to be influenced by the plateau pressure. An increase in Mn content leads to an increase in the plateau region, although the dissociation pressure does not change significantly. Stability of the quaternary hydride was explained qualitatively by means of the model proposed by Miedema et al. (1975). M.L.

**A79-21702** Hydrogen sorption properties in binary and pseudobinary intermetallic compounds. J. Shinar, I. Jacob, D. Shaltiel (Jerusalem, Hebrew University, Jerusalem, Israel), and D. Davidov (Jerusalem, Hebrew University, Jerusalem, Israel; Campinas, Universidade Estadual, Campinas, São Paulo, Brazil). In: Hydrides for energy storage; Proceedings of the International Symposium, Geilo, Norway, August 14-19, 1977. Oxford, Pergamon Press, Ltd., 1978, p. 337-352. 15 refs. Research supported by the National Council of Research and Development of Israel, Kernforschungsanlage Jülich, and Conselho Nacional de Pesquisas.

Particular attention is given to the systems:  $\text{TiFe}(0.8)\text{X}(0.2)$  where  $X = \text{Mn, Cr, V, Co, Ni, Cu}$ ;  $\text{LaNi}_5(5-x)\text{Cu}(x)$  where  $x$  is in the range 1-4; and  $\text{Zr/A}(x)\text{B}(1-x)/2$  where  $x$  is in the range 0-1,  $A = \text{V, Cr, Mn}$ , and  $B = \text{Fe, Co}$ . The observation of plateaus in the dissociation isotherms of some of the hydrides of these intermetallic compounds enables the extraction of the hydride's heat of formation. It is found that the heats of formation do not always satisfy the rule of reverse stability. An alternative preliminary model is suggested to account for relative changes of heats of formation. The model takes into consideration the various interstitial sites occupied by the hydrogen atoms and gives information about the minimum configurational energy for the hydrogen in various sites. B.J.

**A79-21703** The metallurgy and production of rechargeable hydrides. G. D. Sandrock (International Nickel Research and Development Center, Suffern, N.Y.). In: Hydrides for energy storage; Proceedings of the International Symposium, Geilo, Norway, August 14-19, 1977. Oxford, Pergamon Press, Ltd., 1978, p. 353-393. 20 refs. Research supported by the International Nickel Co. and ERDA.

The hydrogen storage properties of metal alloy hydrides are intimately related to the metallurgy and microstructures of those alloys. The understanding of the metallurgy then becomes an important consideration in the practical production of a given alloy for hydrogen storage applications. Using FeTi and nickel-mischmetal-calcium as representatives of AB and AB<sub>5</sub> compounds, respectively, interrelations among composition, alloy microstructure, and hydrogen storage properties are presented in relation to large scale melting considerations. (Author)

**A79-21704** A new rationale for the hysteresis effects observed in metal-hydrogen systems. C. E. Lundin and F. E. Lynch (Denver, University, Denver, Colo.). In: Hydrides for energy storage; Proceedings of the International Symposium, Geilo, Norway, August 14-19, 1977. Oxford, Pergamon Press, Ltd., 1978, p. 395-405. 20 refs. ARPA Order 2552.

Recent interest in metal-hydrogen systems has been intensified by the potential of certain types of hydrides to store hydrogen for energy purposes. However, the observed hysteresis results in a reduced thermodynamic efficiency in various applications of metal-hydrogen systems. In this paper, a general theory based on a model of induced lattice strains during hydrogen adsorption and its relief on desorption is proposed to account for hysteresis effects observed in metal-hydrogen systems. Earlier theories are based on macroscopic effects, but the new rationale relies on an atomistic model. It focuses on the effect of hydrogen atoms occluded in the interstitial sites in the metal lattice and the resulting strains imposed. It is shown that the strain characteristics of the class of metal-hydrogen compounds for energy storage purposes contribute significantly to hysteresis effects, and that the thermodynamic stability of the hydride correlates with the interstitial hole size of the atomic lattice. S.D.



**A79-21706** *Heat transfer characteristics of porous metallic matrix metal-hydrides.* M. Ron and M. Elemelach (Technion - Israel Institute of Technology, Haifa, Israel). In: *Hydrides for energy storage*; Proceedings of the International Symposium, Geilo, Norway, August 14-19, 1977. Oxford, Pergamon Press, Ltd., 1978, p. 417-430. 24 refs.

Metal hydrides (MH) consolidated into a highly porous metallic matrix have been suggested as a way to overcome the problem of the poor heat transfer response of a powder bed and to provide a more efficient and simple hydrogen storage device. The utilization of the porous matrix is particularly important for MH systems with relatively high heat of formation, and ultimate hydrogen content, such as magnesium and magnesium alloy hydrides. The use of the porous matrix makes it possible to design a considerable area of heat contact between the surface of the energy conversion device and the porous matrix. B.J.

**A79-21707** *The effect of induced disorder on the hydrogenation behaviour of the phase ZrCo.* S. J. C. Irvine and I. R. Harris (Birmingham, University, Birmingham, England). In: *Hydrides for energy storage*; Proceedings of the International Symposium, Geilo, Norway, August 14-19, 1977. Oxford, Pergamon Press, Ltd., 1978, p. 431-446. 12 refs. Research supported by the Science Research Council.

The paper reports on P-C-T, X-ray diffraction, and magnetic measurements on the ZrCo-H system. Hydrogenation of ZrCo occurs readily at 473 K and at a hydrogen pressure as low as 200 torr. The hydriding isotherms indicate an extensive solid solution region based on the bcc phase up to about 0.35 H/M for the 573 K isotherm. In the pressure range 0.2 torr to 590 torr and temperature range 423-773 K there are three phases: the initial alpha phase based on the CsCl structure and the two hydride phases. The lower hydrogen concentration phase is evidently formed by a peritectoid reaction. X-ray diffraction data indicate a highly strained lattice for the hydride phases, and the reaction measurements on the bcc phase after cycling across the phase boundary and then outgassing at 423 K indicate a significantly disordered CsCl lattice which is a reflection of the disorder within the hydride phases. The disordering effect results in the appearance of a field dependent contribution to the magnetic susceptibility, indicating ferromagnetic ordering. P.T.H.

**A79-21709** *Electrochemical utilization of metal hydrides.* K. Videm (Institut for Atomenergi, Kjeller, Norway). In: *Hydrides for energy storage*; Proceedings of the International Symposium, Geilo, Norway, August 14-19, 1977. Oxford, Pergamon Press, Ltd., 1978, p. 463-477. 14 refs.

The paper briefly describes materials and electrochemical cells for the utilization of metal hydrides and discusses the potential of hydride electrochemical systems. Emphasis is on cells that are based on reactions with hydrogen without handling hydrogen in gaseous form. A system for supplying a house with heat and electric power is shown, consisting of an electrochemical cell with a metal hydride anode and an oxygen electrode for current generation. A hydrogen-hydride-air storage battery is also schematized, which can be charged and discharged as a normal secondary cell, but which has the advantage of also being chargeable with hydrogen gas. Data on the energy per unit weight of some reactions of interest for electrochemical current generation are presented. The required properties for materials of hydrogen electrodes are examined, and the state of the search for such materials is reviewed. P.T.H.

**A79-21710** *Hydrogen storage electrode systems.* F. A. Lewis (Belfast, Queen's University, Belfast, Northern Ireland). In: *Hydrides for energy storage*; Proceedings of the International Symposium, Geilo, Norway, August 14-19, 1977. Oxford, Pergamon Press, Ltd., 1978, p. 479-484. 58 refs.

Hydrogen storage is considered with reference to application of metals which readily permit diffusion of hydrogen. Substantial hydrogen gas pressures can be developed inside hollow tubes by electrolytically discharging hydrogen on their outer surfaces, and intratube absorption of hydrogen by metals or intermetallic com-

pounds would permit removal of hydrogen in a discharge cycle at a relatively fixed electrode potential. Hollow electrode systems, the choice of tube metal, and possibilities of isotope separation are discussed. M.L.

**A79-21711** *Hydrogen electrochemical storage by substituted LaNi5 compounds.* A. Percheron-Guegan, J. C. Achard (CNRS, Laboratoire de Chimie Métallurgique et Spectroscopie des Terres Rares, Meudon, Hauts-de-Seine, France), J. Saradin, and G. Bronoel (Ecole Nationale Supérieure d'Electrochimie et d'Electrometallurgie, Saint-Martin-d'Hères, Isère, France). In: *Hydrides for energy storage*; Proceedings of the International Symposium, Geilo, Norway, August 14-19, 1977. Oxford, Pergamon Press, Ltd., 1978, p. 485-490. 8 refs.

An attempt is made to report on experiments in which hydrides were obtained from intermetallic compounds consisting of Ni, La, and one other element (Cu, Cr, Al, or Mn). Attention is given to the effects of substitution on hydride stability and capacity, as well as to the electrochemical capacity of the hydrides at room temperature and 40 C. The use of the studied compounds as hydrogen storage electrodes is considered to be very attractive. It is noted that some of these compounds have been fabricated into compact industrial electrodes with a capacity higher than 300 mAh/g between -10 and plus 50 C. F.G.M.

**A79-21713** *Rare earth and actinide intermetallics as hydrogenation catalysts.* W. E. Wallace (Pittsburgh, University, Pittsburgh, Pa.). In: *Hydrides for energy storage*; Proceedings of the International Symposium, Geilo, Norway, August 14-19, 1977. Oxford, Pergamon Press, Ltd., 1978, p. 501-514. 14 refs. Research supported by the Pennsylvania Science and Engineering Foundation and NSF.

Rare earth intermetallics and certain actinide intermetallics have been found to be catalytically active for the formation of methane from CO and H<sub>2</sub>; the rare earth intermetallics have also been found to be active as synthetic ammonia catalysts. The present paper describes the investigation of such catalysts by means of surface energy determinations, X-ray diffraction, SEM, energy dispersive analysis by X-rays, and AES. These studies indicate that the original intermetallic has been transformed during reaction into a substrate of rare earth or actinide oxides supporting nodules (about 0.5 microns in diameters) of the transition element, these nodules assumed to be the active catalysts. B.J.

**A79-21714** *Mixing effects of two different types of hydrides.* S. Suda and M. Uchida (Kogakuin University, Tokyo, Japan). In: *Hydrides for energy storage*; Proceedings of the International Symposium, Geilo, Norway, August 14-19, 1977. Oxford, Pergamon Press, Ltd., 1978, p. 515-525. 9 refs.

A method is proposed for modifying and controlling the P-T-x relations as well as the plateau shapes of known hydrides through a simple combination of two different kinds of hydriding compounds. Two mixtures of LaNi<sub>5</sub> + TiFe and LaNi<sub>5</sub> + Ti(0.8)Zr(0.2)Cr(0.8)Mn(1.2) were selected to illustrate the present method and the equilibrium pressure and composition relations for a series of mixtures were measured under three isothermal conditions of 30, 40, and 50 C, respectively. No interaction between the two constituents were observed through 100 cycles of sorption-desorption. B.J.

**A79-21715** *Applications of metal hydrides.* J. J. Reilly (Brookhaven National Laboratory, Upton, N.Y.). In: *Hydrides for energy storage*; Proceedings of the International Symposium, Geilo, Norway, August 14-19, 1977. Oxford, Pergamon Press, Ltd., 1978, p. 527-550. 28 refs. Contract No. EY-76-C-02-0016.

Some criteria which a metal hydride must satisfy to serve as a practical energy or hydrogen storage medium are examined. The most important of these criteria is that the metal hydride be easily

formed and decomposed. A further important criterion is the heat of decomposition, which even in the case of unstable hydrides is substantial. V.P.

**A79-21716** HYCSOS - A system for evaluation of hydrides as chemical heat pumps. I. Sheft, D. M. Gruen, G. J. Lamich, L. W. Carlson, A. E. Knox, J. M. Nixon, and M. H. Mendelsohn (Argonne National Laboratory, Argonne, Ill.). In: Hydrides for energy storage; Proceedings of the International Symposium, Geilo, Norway, August 14-19, 1977. Oxford, Pergamon Press, Ltd., 1978, p. 551-567. 5 refs.

The Argonne HYCSOS system is a two hydride concept, operating as a chemical heat pump for storage and recovery of thermal energy for heating, cooling and energy conversion. Hydrogen gas is transferred from one hydride bed by thermal energy input at a characteristic temperature to a second bed where the hydrogen is absorbed and thermal energy is released at another characteristic temperature. The demonstration unit has four steel tanks of approximately 3 liters free volume each for holding the hydride and is fully instrumented to measure and record system characteristics on a data logger. Remotely valved fluid heat transfer loops are available. Sub-micron steel filters are installed above each tank to retain the alloy particles in the tanks. The thermal energy input is simulated by an 18 KW electric heater. The unit described is an experimental facility of sufficient size to be able to demonstrate the feasibility of heat transfer processes. (Author)

**A79-21717** The hydrogen/hydride energy concept. H. Buchner (Daimler-Benz AG, Stuttgart, West Germany). In: Hydrides for energy storage; Proceedings of the International Symposium, Geilo, Norway, August 14-19, 1977. Oxford, Pergamon Press, Ltd., 1978, p. 569-599. 21 refs.

The paper reviews the hydride energy concept, discusses several applications of the concept in energy systems, and discusses some of the materials science aspects of the problem of hydride energy. Test data on automotive vehicles with hydride experimental engines are presented. A hydride air conditioning system is described. Some systems for hydride systems for waste heat storage are presented. The fundamentals of hydrogen/deuterium dissociation when Ti-Ni alloys are used are reviewed. P.T.H.

**A79-21807\*** Effect of grain boundaries in silicon on minority-carrier diffusion length and solar-cell efficiency. T. Daud, K. M. Koliwad (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.), and F. G. Allen (California University, Los Angeles, Calif.). *Applied Physics Letters*, vol. 33, Dec. 15, 1978, p. 1009-1011. Contract No. NAS7-100.

The spatial variation of minority-carrier diffusion length in the vicinity of a grain boundary for a polycrystalline silicon sheet has been measured by the use of the EBIC technique. The effect of such a variation on solar-cell output has then been computed as a function of grain size. Calculations show that the cell output drops considerably for grain size smaller than three times the bulk diffusion length. (Author)

**A79-21825** Geothermal energy: Its past, present and future contributions to the energy needs of man. H. C. H. Armstead. London, E. & F.N. Spon, Ltd.; New York, Halsted Press, 1978. 382 p. 200 refs. \$27.50.

Procedures for obtaining and applying energy from geothermal fields are examined. Topics considered include exploration, drilling, bore characteristics and their measurement, fluid collection and transmission, electric power generation from geothermal energy, geothermal space heating, domestic hot water supplies, and air conditioning. Geothermal field geology, dual and multipurpose projects, the control and safety of geothermal installations, economic considerations, chemical and metallurgical problems, environmental problems, and future prospects are discussed. M.L.

**A79-22099** Materials for low-cost solar cells. F. A. Shirland and P. Rai-Choudhury (Westinghouse Research and Develop-

ment Center, Pittsburgh, Pa.). *Reports on Progress in Physics*, vol. 41, Dec. 1978, p. 1839-1879. 55 refs.

Photovoltaic materials are reviewed with regard to their possible use in systems that could provide very large amounts of electric power from the sun before the end of the century. The key is taken to be the cost of the solar cells which are considered to be presently about two orders of magnitude too high. Only silicon, in single crystal or ribbon form, or CdS in thin-film form are thought to be sufficiently developed to permit their possible large-scale exploitation by the last decade of the century. Silicon is considered to have the advantage over CdS at present for large-scale use because of the higher performance levels and the broader existing technology base. CdS thin films are considered to have greater potential if selected improvements can be effected in design and performance, because of lower projected cost and the ease of automating manufacture. (Author)

**A79-22223** The oscillating water column wave-energy device. D. V. Evans (Bristol University, Bristol, England). *Institute of Mathematics and Its Applications, Journal*, vol. 22, Dec. 1978, p. 423-433. 7 refs.

An expression is obtained for the efficiency of wave-energy absorption of a float connected to a spring-dashpot system on the top of a column of fluid bounded by two closely-spaced vertical parallel plates or a narrow tube immersed under waves. The method makes extensive use of the approximate solution using matched asymptotic expansions obtained by Newman (1974) to the corresponding problem when the float-spring-dashpot system was absent. It is shown that for plates of equal length the maximum possible efficiency is 50%, and that for the three-dimensional case it is theoretically possible to capture the energy in a wave whose crest length is greater than the tube diameter. (Author)

**A79-22236** The synergetics of the catalytic D-D-fusion-fission breeder. K. F. Schoepf (McMaster University, Hamilton, Ontario, Canada; Innsbruck, Universität, Innsbruck, Austria) and A. A. Harms (McMaster University, Hamilton, Ontario, Canada). *Nuclear Fusion*, vol. 19, Jan. 1979, p. 5-19. 16 refs. Research supported by the National Research Council of Canada.

A parametric assessment of the D-D-fuelled fusion-fission hybrid reactor is undertaken. Based on the fusion hybrid reactor characteristic that the attainment of a 'break-even' plasma is not essential for the maintenance of a viable system, its capabilities of net power generation and fissile fuel production at low plasma fusion gains are investigated in this paper. Analysis of the isotopic and energetic balances under steady-state conditions has resulted in the formulation of essential relationships involving fissile fuel yield, system power, fusion plasma efficiency, and plutonium content in the blanket material. The increasing systems design flexibility associated with the catalysed-D hybrid reactor suggest the definite possibility of an earlier introduction of advanced fusion cycles in the production of nuclear energy. (Author)

**A79-22237** Minimum-average-B wells in linked magnetic mirror fields. J. C. Riordan, A. J. Lichtenberg, and M. A. Lieberman (California University, Berkeley, Calif.). *Nuclear Fusion*, vol. 19, Jan. 1979, p. 21-31. 14 refs. NSF Grant No. ENG-75-02709; Contract No. E(04-3)-3-PA-215.

Minimum-average-B wells are examined for use in hydromagnetically stable linked mirror traps. A multipole expansion to fourth order in radius is used. The magnetic field shapes are chosen by a combination of heuristic and variational techniques to optimize the well radius. Numerical results show that the optimized wells are more practical than was previously realized, and that the required field shapes can be achieved with a simple coil configuration. (Author)

**A79-22238** Measurements of plasma rotation in tokamak LT-3. M. G. Bell (Australian National University, Canberra, Australia). *Nuclear-Fusion*, vol. 19, Jan. 1979, p. 33-38. 20 refs.

Rotation of the plasma in LT-3 has been measured from the Doppler shift of lines emitted by ionized oxygen impurities. In stable discharges, toroidal rotation of the ions in the direction of the discharge current was measured at velocities of up to 5 km/s, while poloidal rotation was observed in the electron diamagnetic drift direction, reaching linear velocities of 1.6 km/s at a minor radius of 5 cm. In unstable discharges, the plasma rotation collapses at the disruptions and then reappears as the magnetic surfaces are reformed. (Author)

**A79-22239** Particle orbits in field-reversed mirrors. M. Y. Wang and G. H. Miley (Illinois, University, Urbana, Ill.). *Nuclear Fusion*, vol. 19, Jan. 1979, p. 39-49. 18 refs. Research supported by the U.S. Department of Energy.

The particle orbits in field-reversed mirrors (FRM) are studied. It is found that the orbit can be expressed in terms of the first and third kind of elliptic integral for particles moving in the centre plane of the Hill vortex configuration. Requirements for absolute confinement are obtained, and four distinct classes of orbits are identified that are bounded by limits on the canonical angular momentum. The improvement in confinement over a simple mirror as well as natural divertor properties of the FRM are illustrated by these results. (Author)

**A79-22240** Empirical scaling laws for energy confinement in ohmically-heated tokamaks. W. Pfeiffer and R. E. Waltz (General Atomic Co., San Diego, Calif.). *Nuclear Fusion*, vol. 19, Jan. 1979, p. 51-67. 43 refs. Contract No. EY-76-C-03-0167.

Differences among the empirical scaling laws proposed for tokamak energy confinement are clarified, and the various scaling laws are reconciled, insofar as is possible. The energy confinement and replacement times are defined, scaling laws and their interpretation are discussed, and emphasis is placed on the limitation imposed by ohmic heating as well as on the need for information about the temperature dependence of confinement time. A compilation of over 100 data points (discharges) is provided, along with a basis for their selection and histograms of scaling variables. Linear regression analysis is used to determine scaling laws from the data, a temperature scaling law describing the entire data base is given, and its faithfulness as a general representation is tested by fits to data subsets. Confinement-time scalings are also presented, and one that is temperature independent is compared with previously proposed scalings. F.G.M.

**A79-22241** An overview of design space for small fusion targets. R. C. Kirkpatrick (California, University, Los Alamos, N. Mex.). *Nuclear Fusion*, vol. 19, Jan. 1979, p. 69-79. 7 refs.

A twelve-parameter burn code has been used to gain an overview of the design space available for laser and E-beam fusion targets. The results of a few thousand implosion calculations are presented in terms of an initial-condition space. The initial conditions include temperature, density, and pusher jump-off velocity. For marginal driving energy there is an isolated region in the initial-condition space (temperature, density) for which ignition may be achieved. (Author)

**A79-22242** Space-dependent thermal stability of reacting tokamak plasmas. W. A. Houlberg and R. W. Conn (Wisconsin, University, Madison, Wis.). *Nuclear Fusion*, vol. 19, Jan. 1979, p. 81-92. 21 refs. Research supported by the Wisconsin Electric Utilities Research Foundation; Contract No. ET-76-S-02-2272.

A technique is presented for the analysis of thermal stability in reacting tokamak plasmas using a one-dimensional time-dependent fluid-transport model. Application is made to the analysis of density-related thermal instabilities in a neutral-beam-driven two-component plasma (TETR) and a conceptual reactor-size ignited plasma (UWMAK-III). A density-driven thermal instability can exist when the particle confinement varies as particle density. This condition is satisfied by the trapped-ion-mode diffusion model and an empirical model. A time delay in the heating due to finite alpha thermalization does not significantly alter the character of the instability at normal plasma densities. A linear feedback response for

the particle source is found to provide a stabilized equilibrium in all cases. Strong radial variation of the transport and physical properties of the plasma is found not to introduce radial-dependent feedback requirements. Feedback on the average density is sufficient for stabilization with moderate response times. (Author)

**A79-22243** Alpha transport and blistering in tokamaks. W. Bauer, K. L. Wilson, C. L. Bisson, L. G. Haggmark (Sandia Laboratories, Livermore, Calif.), and R. J. Goldston (Princeton University, Princeton, N.J.). *Nuclear Fusion*, vol. 19, Jan. 1979, p. 93-103. 34 refs. Research supported by the U.S. Department of Energy.

The particle flux and angular distribution of 3.5 MeV alpha particles impinging on the first wall from uncontained banana orbits in an axisymmetric tokamak reactor have been calculated. The resulting helium concentration profiles in the first wall can give rise to surface exfoliation under specified conditions. The major mitigating factor is the simultaneous surface recession due to sputtering by the D-T charge-exchange neutral flux. For the parameters used in these calculations blistering in high-sputtering-rate materials such as beryllium is unlikely, whereas in low-sputtering-rate materials such as niobium helium-induced surface deformation is quite probable. (Author)

**A79-22244** Local theory of finite-beta, collisional drift modes. R. R. Dominguez (California, University, Berkeley, Calif.). *Nuclear Fusion*, vol. 19, Jan. 1979, p. 105-107. NSF Grant No. ENG-75-02709; Contract No. E(04-3)-34-PA-215.

The stability of the collisional drift-Alfven mode in a shearless magnetic field is investigated in the local approximation. In the absence of temperature gradients, it is shown that the beta-threshold for stability in a collisional finite-beta plasma is essentially the same as the collisionless results, beta greater than 0.15. (Author)

**A79-22265** Investigations of solar heat production for household heating in Turkey (Travaux de production de chaleur solaire pour le chauffage d'habitat en Turquie). M. Babayigit (Mineral Research and Exploration Institute of Turkey, Ankara, Turkey). *Coopération Méditerranéenne pour l'Energie Solaire, Revue Internationale d'Héliotechnique*, 2nd Semester, 1978, p. 7-11. 7 refs. In French.

A Turkish research program on the use of solar energy for household heating is surveyed. The research, conducted at Marmaris, is concerned with the use of a passive method, the Trombe wall. Insolation data; energy production, consumption, and cost data; and calculations and parameters concerning the physics of household heating are presented. The order of priority for supplying heat to different classes of dwellings is reported. M.L.

**A79-22266** Calculation of solar energy incident on non-horizontal surfaces over Turkey. E. Tasdemiroglu, F. Ramos Berjano, and D. Tınaut (Mineral Research and Exploration Institute of Turkey, Ankara, Turkey; Consejo Superior de Investigaciones Científicas, Madrid, Spain). *Coopération Méditerranéenne pour l'Energie Solaire, Revue Internationale d'Héliotechnique*, 2nd Semester, 1978, p. 12-15.

The daily total, direct, and diffuse radiation received by southwardly inclined surfaces (0 to 90 deg) at the latitude of Ankara (approximately 40 deg) is calculated by applying the Liu and Jordan relations to data on radiation received by horizontal surfaces at 43 stations. Values of radiation received hourly by a surface inclined 30 deg at Ankara are provided for each month. The computer program sequence of parameter determinations is indicated. M.L.

**A79-22267** Solar energy diagrams (Les diagrammes solaires énergétiques). J.-L. Izard (Aix-Marseille I, Université, Marseille, France). *Coopération Méditerranéenne pour l'Energie Solaire, Revue Internationale d'Héliotechnique*, 2nd Semester, 1978, p. 16-20. 12 refs. In French.

Visibility and iso-incidence curves for planes inclined 15 to 90 deg and oriented 50 to 85 deg with respect to the sun are presented.

It is intended that this information on solar radiation be applied by architects who wish to determine the effects of architectural (for example, shadowing) features on the solar energy received by the glass surfaces of a house. Parameters for different glass structures and procedures for calculating direct, diffuse, and reflected radiation are presented. M.L.

**A79-22268** Solar heating using a heat pump and cold collectors (Chauffage solaire utilisant une pompe à chaleur et des capteurs froids). A. Cordier and G. Gessinn (Toulouse III, Université, Toulouse, France). *Coopération Méditerranéenne pour l'Energie Solaire, Revue Internationale d'Héliotechnique*, 2nd Semester, 1978, p. 21-26. 8 refs. In French.

A solar heating system which uses flat-plate collectors kept at 0 C is described, and a simulation study to determine optimum operating conditions for the system is reported. The heat pump, storage system, evaporators, and various collectors are characterized, and the functioning of the system with alternative components is examined, with attention to potential problems caused by a build-up of freon vapor pressure and by water condensation on the cold collectors. The energy output of the system is calculated for some operating conditions. M.L.

**A79-22269** Solar thermal conversion installations in the medium power range - The Thek project (Unités de conversion héliothermique dans la gamme des moyennes puissances, le projet 'Thek'). G. Peri, J. Desautel, B. Imbert, M. Audibert, R. Pasquetti, and J.-P. Batistelli (Aix-Marseille I, Université, Marseille, France). *Coopération Méditerranéenne pour l'Energie Solaire, Revue Internationale d'Héliotechnique*, 2nd Semester, 1978, p. 27-31. In French.

The CNRS Thek project to develop central-focusing solar energy installations is discussed. Factors involved in the design of collector modules are examined with attention to the module shape, surface, absorption characteristics, mounting, and automatic tracking. A procedure for experimental testing is considered. M.L.

**A79-22270** Storage efficiency in a solar plant (Rendement d'un stock dans une installation solaire). L. Keller. *Coopération Méditerranéenne pour l'Energie Solaire, Revue Internationale d'Héliotechnique*, 2nd Semester, 1978, p. 35-37. In French.

Energy storage procedures for solar plants are analyzed and compared, and it is concluded that storage involving latent heat is slightly more advantageous than storage involving sensible heat, and that both storage procedures are preferable to storage that involves reaction heat. The analysis assumes that a precise storage temperature can be maintained. Some numerical calculations of the storage efficiency are presented. M.L.

**A79-22271** A hybrid chemical concept for solar energy storage (Communication sur un concept chimique hybride pour le stockage de l'énergie solaire). A.-C. Vialaron (CNRS, Institut du Génie Chimique, Toulouse, France). *Coopération Méditerranéenne pour l'Energie Solaire, Revue Internationale d'Héliotechnique*, 2nd Semester, 1978, p. 38-41. 5 refs. In French.

Solar energy storage procedures that merely involve storage of heat are compared with hybrid storage procedures that involve a chemical reaction as well as thermal storage. A sulfur dioxide and magnesium oxide system that utilizes the dissociation of water (hydrogen production) is described, and two scenarios for application of this system are considered. The system capabilities and requirements are examined. M.L.

**A79-22272** Storage tank efficiency as simulated in a Markovian model of meteorology. R. Lestienne (CNRS, Paris, France). *Coopération Méditerranéenne pour l'Energie Solaire, Revue Internationale d'Héliotechnique*, 2nd Semester, 1978, p. 42-45.

The storage efficiency of a solar energy production-storage system with randomly varying daily energy production is characterized in terms of a Markov model. Sunshine duration and production probability densities for 'good' and 'bad' days are considered in this

procedure. The storage efficiency for various meteorological conditions occurring in southern France is discussed. M.L.

**A79-22273** Electrochemical use of biomass (Utilisations électrochimiques de la biomasse). I. Gillet (Liège, Université, Liège, Belgium). *Coopération Méditerranéenne pour l'Energie Solaire, Revue Internationale d'Héliotechnique*, 2nd Semester, 1978, p. 46-50. In French.

Electrochemical oxidation studies of glucose and glycerine, which are substances derived from plant biomass, are reported. It is suggested that these substances serve as solar energy storage systems. The results of preliminary experiments are considered with reference to the determination of parameters that would enable the design of solar energy storage systems which use substances obtained from plant biomass. M.L.

**A79-22274** Industrial aspects in solar energy instruction (Aspect industriel dans l'enseignement de l'héliotechnique). M. Touchais (Le Mireio, Salon-de-Provence, Bouches-du-Rhône, France). *(Coopération Méditerranéenne pour l'Energie Solaire, Rencontre Internationale, 17th, Hamburg, West Germany, July 13, 1978.) Coopération Méditerranéenne pour l'Energie Solaire, Revue Internationale d'Héliotechnique*, 2nd Semester, 1978, p. 51-55. In French.

Two introductory courses on solar energy are described. One course seeks to correct commonly held erroneous concepts concerning solar energy and to indicate areas requiring future research. The second course provides a technical analysis of collectors, thermal storage systems, and related equipment, and suggests ways of organizing solar energy system components for various applications. M.L.

**A79-22320** Charge transfer by surface states in the photo-electrolysis of water using a semiconductor electrode. M. Nishida (Kanazawa Institute of Technology, Nonoichi, Japan). *Nature*, vol. 277, Jan. 18, 1979, p. 202, 203. 14 refs.

A theoretical treatment of electron tunneling between a semiconductor and an electrolyte via surface states is given. A theory of interface states in tunnel MOS devices is applied to the semiconductor-electrolyte interface. It is shown that a rather high efficiency for holes at the interface can be obtained when the electron population of surface states is controlled by the electrolyte and the surface states are almost completely occupied. The analysis is performed in the context of photolysis of water using n-TiO<sub>2</sub> semiconductors. F.G.M.

**A79-22324** The Sunship. G. Khoury (Imperial College of Science and Technology, London, England) and E. Mowforth (Surrey, University, Guildford, England). *Sunworld*, vol. 2, Nov. 1978, p. 92-94.

Development of a solar-powered airship - Sunship - is proposed for moving substantial payloads in areas where there is sufficient solar-energy intake. It is suggested that an airship with a conventional configuration and with an array of solar cells over the greater part of its skin area would be capable of carrying a working load of 3 to 5 tons. Geographic range of potential operation, present and future solar cell costs, and hull structure are considered. M.L.

**A79-22325** Solar water heaters for a cold climate. T. R. Shelley (Montana College of Mineral Science and Technology, Butte, Mont.). *Sunworld*, vol. 2, Nov. 1978, p. 112-116.

Solar water heating systems designed to operate at January temperatures (approximately -7 to -9 C) in Butte, Montana are described. The goal was to heat the water in a 150-liter domestic hot-water tank to 66 C, and various combinations of collectors, heat exchangers, and working fluids are studied. The single-glazed aluminum collector is found to be just as effective as copper or aluminum double-glazed collectors, while the heat exchanger using the coil of copper pipe on the outside is found to be suitable even though less efficient than the pipe in the oil drum. System construction costs are estimated. M.L.

**A79-22338 #** Influences on exhaust emissions from automotive gas turbines. R. Buchheim (Volkswagenwerk AG, Wolfsburg, West Germany). (*American Society of Mechanical Engineers, Gas Turbine Conference, London, England, Apr. 9-13, 1978, Paper 78-GT-85.*) ASME, Transactions, Journal of Engineering for Power, vol. 101, Jan. 1979, p. 186-194. 16 refs. Research sponsored by the Bundesministerium für Forschung und Technologie.

Experimental and theoretical investigations on conventional diffusion flame type combustors and on premix/prevaporize combustors were performed. The range of pollutant levels attainable with the various types of combustors is analyzed. The effect of different fuel nozzles, various fuels, and gas turbine thermodynamic cycle data on exhaust emissions is shown. Correlations are developed as far as possible. (Author)

**A79-22365 \*** Investigation of a staged plasma-focus apparatus. J. H. Lee (Vanderbilt University, Nashville, Tenn.), D. R. McFarland (NASA, Langley Research Center, Hampton, Va.), and W. L. Harries (Old Dominion University, Norfolk, Va.). *Plasma Physics*, vol. 20, Oct. 1978, p. 1025-1038. 11 refs. Grants No. NSG-1235; No. NSG-1022.

A new staged plasma-focus geometry combining two Mather-type plasma-focus guns was constructed, and the current-sheet dynamics were investigated. The production of simultaneous pairs of plasma foci was achieved. The intensities of X-ray and fusion-neutron emission were measured and found to agree with the scaling law for a plasma focus. Advantages of this new geometry include the possibility of using plasma-focus type pinches in multiple arrays at power levels beyond the validity regime of the current scaling law for a single gun. (Author)

**A79-22369** Plasma density measurements on refuelling by solid hydrogen pellets in a rotating plasma. L. W. Jorgensen and A. H. Sillesen (EURATOM and Riso National Laboratory, Roskilde, Denmark). *Plasma Physics*, vol. 20, Oct. 1978, p. 1081-1086. 11 refs.

Experimental results are presented on the possibility of refueling future tokamak fusion reactors with frozen D-T pellets. Laser interferometry was used to directly measure the increase in plasma density caused by ablation of a solid hydrogen pellet situated in a rotating plasma. Nearly half of the pellet material evaporated and seemed to be completely ionized, resulting in an increase in the amount of plasma equivalent to one third of the total amount of plasma before refueling. The gross behavior of the plasma was unchanged. B.J.

**A79-22379** A simple neutral density profile calculation for tokamaks with  $\lambda_{sub}$  much smaller than  $a$ . R. J. Goldston (Princeton University, Princeton, N.J.). *Plasma Physics*, vol. 20, Nov. 1978, p. 1199-1203. 5 refs. Contract No. EY-76-C-02-3073.

A simple and expeditious technique is developed for calculating the neutral density profile in the dense region of large tokamak plasmas, where the mean free path is small in comparison to other macroscopic scales. The method rests on determining the local logarithmic derivative of the number of neutrals from a self-consistent calculation of the radial flux of neutrals, combined with a condition on the divergence of the neutral radial flux. The results from this simple technique are compared with a more time-consuming Monte-Carlo calculation, and good agreement is found. (Author)

**A79-22427** Wave reflection from the lower hybrid surface - A toroidal effect. E. Ott, J.-M. Wersinger, and P. T. Bonoli (Cornell University, Ithaca, N.Y.). *Physics of Fluids*, vol. 22, Jan. 1979, p. 192, 193. 5 refs. Research supported by the U.S. Department of Energy.

An analysis is performed which demonstrates that the toroidal geometry of a cold plane-stratified toroidal equilibrium plasma leads to reflection of cold lower hybrid waves at the lower hybrid layer rather than resonance. This effect is attributed to the fact that the toroidal equilibrium magnetic field does not lie in the lower hybrid

surface. A numerical calculation of lower-hybrid-wave propagation in a specific model toroidal equilibrium is presented which shows that after the first few bounces of an externally launched cold lower hybrid wave off the lower hybrid surface, thermal effects come into play, and the wave will mode-convert to a hot plasma wave or be absorbed. It is noted that for a central temperature of 1 keV, mode conversion occurs before the wave has a chance to bounce. F.G.M.

**A79-22516 \* #** Energy and remote sensing applications. R. A. Summers (U.S. Department of Energy, Washington, D.C.), W. L. Smith (Spectral Data Corp., Arlington, Va.), and N. M. Short (NASA, Goddard Space Flight Center, Greenbelt, Md.). In: International Symposium on Remote Sensing of Environment, 12th, Manila, Philippines, April 20-26, 1978, Proceedings. Volume 1.

Ann Arbor, Mich., Environmental Research Institute of Michigan, 1978, p. 395-413. 27 refs.

The nature of the U.S. energy problem is examined. Based upon the best available estimates, it appears that demand for OPEC oil will exceed OPEC productive capacity in the early to mid-eighties. The upward pressure on world oil prices resulting from this supply/demand gap could have serious international consequences, both financial and in terms of foreign policy implementation. National Energy Plan objectives in response to this situation are discussed. Major strategies for achieving these objectives include a conversion of industry and utilities from oil and gas to coal and other abundant fuels. Remote sensing from aircraft and spacecraft could make significant contributions to the solution of energy problems in a number of ways, related to exploration of energy-related resources, the efficiency and safety of exploitation procedures, power plant siting, environmental monitoring and assessment, and the transportation infrastructure. G.R.

**A79-22522 #** Remote sensing use in hydraulic planification in Mexico. J. A. Díez Pérez (Comisión del Plan Nacional Hidráulico, Secretaría de Agricultura y Recursos Hidráulicos, Mexico City, Mexico). In: International Symposium on Remote Sensing of Environment, 12th, Manila, Philippines, April 20-26, 1978, Proceedings. Volume 1.

Ann Arbor, Mich., Environmental Research Institute of Michigan, 1978, p. 497-502.

Mexican participation in NASA Mission 91 projects is reviewed. The mission objectives are the detection of mineral deposits and geothermal zones, data collection for geohydrological studies, flood identification, and crop classification. Projects described include a water pollution study over Acapulco Bay, citrus inventory in the main orange-producing Mexican state of Nuevo Leon, a joint project with USDA to identify hosts of the Mediterranean fruit fly, and water-resource studies for an inland semiarid region, a coastal semiarid region, and a tropical jungle. The advantages of remote sensing as a useful planning tool for regional and national projects in underdeveloped countries are discussed. F.G.M.

**A79-22557 #** Surtrace - An airborne geochemical system. A. R. Barringer, J. H. Davies, and L. Daubner (Barringer Research, Ltd., Rexdale, Ontario, Canada). In: International Symposium on Remote Sensing of Environment, 12th, Manila, Philippines, April 20-26, 1978, Proceedings. Volume 2.

Ann Arbor, Mich., Environmental Research Institute of Michigan, 1978, p. 975-990.

The described Surtrace system obtains samples of the surface microlayer and, with the aid of the Lasertrace analytical system, determines ppm values for several elements. Airborne, vehicle-mounted, and man-portable versions of the device are designed to aid study of shallow and deep mineral deposits, geothermal regions, and hydrocarbon accumulations. Surface microlayer particulates are removed by application of a vacuum in a semicontinuous operation at flight speeds between 25 and 50 mph, and the sample particulates are affixed on adhesive tape. Examples of application of Surtrace to prospecting are presented. M.L.

**A79-22620 #** Infrared remote sensing on geothermal areas by helicopter. M. Sekioka (Defense Academy, Yokosuka, Kanagawa, Japan) and K. Yuhara (Kyushu University, Fukuoka, Japan). In: International Symposium on Remote Sensing of Environment, 12th, Manila, Philippines, April 20-26, 1978, Proceedings. Volume 3. Ann Arbor, Mich., Environmental Research Institute of Michigan, 1978, p. 1679-1686. 7 refs.

A technique is developed to determine surface temperature distributions by using a helicopter-borne infrared thermographic instrument giving thermal images of television type. Making a helicopter with an open hatch on its floor, through which thermal images are photographed, to hover over the target area, the temperature distributions with high resolution can be obtained in projection on a horizontal plane. Two experimental surveys were performed for several subregions of an active volcanic island. In the first survey, an attempt to print out digitally the ratio of areas between each adjacent isotherm on the isothermal image is carried out with an isothermal area processor. A method converting the isothermal pattern of geothermal fields to a distribution of heat discharge will be applied to such a ratio of areas of isothermal patterns thus obtained in the near future. In the second one, effects of atmospheric absorption and emission between the sensor of the thermocamera and the target area are evaluated using a newly developed helicopter-borne radiosonde system to correct the surface temperatures measured by the thermocamera. (Author)

**A79-22756** The economics of geothermal energy development at the regional level. A. Rose, S. Edmunds, and E. Lofting (California, University, Riverside, Calif.). *Journal of Energy and Development*, vol. 4, Autumn 1978, p. 126-152. 15 refs. NSF Grant No. AER-75-08793.

Regional economics of geothermal energy development are discussed with Imperial County, California as a case study. A multisector input-output analysis is outlined, together with the presentation of a simulated geothermal development scenario. Results of the methodology are given and interpreted, concluding that the impact of energy development on Imperial County will be significantly favorable, with the major points being employment, output and tax revenue incomes. Policies for increasing the net benefits of geothermal development are analyzed with consideration to such possible problems as appreciation of land value, environmental effects, interregional equity, and depletion of geothermal resources. It is noted that the major conclusions are not affected by alternative development scenarios within a broad technically feasible, and economically viable range. A.A.

**A79-22760** Energy for the long run - Fission or fusion. G. L. Kulcinski (Wisconsin, University, Madison, Wis.), G. Kessler (Gesellschaft für Kernforschung mbH, Karlsruhe, West Germany), J. Holdren (California, University, Berkeley, Calif.), and W. Häfele (International Institute for Applied Systems Analysis, Laxenburg, Austria). *American Scientist*, vol. 67, Jan.-Feb. 1979, p. 78-89. 13 refs.

Fusion and fast-breeder fission energies are analyzed in terms of problems and potentials. The status of fission and fusion systems is described, taking into account three thresholds of feasibility: scientific, engineering, and commercial. Degradation of materials due to radiation damage in the reactor environment is considered, as is the potentially hazardous radioactivity associated with isotopes inside the reactors. Consideration is also given to the future commercial feasibility of fission and fusion energies. It is concluded that both fission breeders and DT (deuterium/tritium) fusion have the potential, in terms of fuel supply, for providing extremely large amounts of electricity, with investment in R&D being very heavy and operation of the facilities demanding a high degree of alertness and thoroughness. Further, differences in the physical processes of fission and fusion are noted, particularly the capability of the fusion process to allow for a greater degree of flexibility in the technologies used to harness it. A.A.

**A79-22768** Temperature dependence of photovoltaic solar energy conversion for GaAs homojunction solar cell. P. C. Mathur, J. D. Arora (Delhi, University, Delhi, India), and N. D. Kataria (Delhi, University, Delhi; National Physical Laboratory of India, New Delhi, India). *Solid-State Electronics*, vol. 22, Jan. 1979, p. 111-112. 16 refs.

Calculations are reported for the efficiency of GaAs (p on n) homojunction solar cells in the temperature range 100-675 K for the entire solar spectrum. Calculations are based on available data for band structure effective mass and mobility for n-type and p-type GaAs. It is found that the results are very sensitive to the band parameters and their temperature variation, due to the fact that the dark current density, to which efficiency is extremely sensitive, is quite small in GaAs. B.J.

**A79-22847 #** Thermal converters with transverse thermoelectromotive forces (Termoelementi z poperechnimi termoelektroshiniimi silami). L. I. Anatchuk and V. V. Razin'kov. *Akademii Nauk Ukrain's'koi RSR, Visnik*, vol. 42, Nov. 1978, p. 50-59. 25 refs. In Ukrainian.

The design and principles of thermal converters of various type, based on the Seebeck effect, are examined, and their efficiency is compared. The theory of devices employing short-circuited thermoelements, of the type used to measure IR and laser radiations, is outlined. V.P.

**A79-22855** Gold, silver, chromium, and copper cermet selective surfaces for evacuated solar collectors. D. R. McKenzie (Sydney, University, Sydney, Australia). *Applied Physics Letters*, vol. 34, Jan. 1, 1979, p. 25-28. 9 refs. Research supported by the Science Foundation for Physics.

Cermet solar selective surfaces of absorptance over 0.90 and emittance less than 0.05 have been prepared by vacuum coevaporation of alumina and spinel with gold, silver, chromium, and copper. Grading of composition was employed to enhance the absorptance. The effect of heat treatment in vacuum up to 500 C was studied and the chromium-alumina cermet shown to be the best candidate for vacuum-insulated collectors. (Author)

**A79-22856** A two-junction cascade solar-cell structure. S. M. Bedair, M. F. Lamorte (Research Triangle Institute, Research Triangle Park, N.C.), and J. R. Hauser (North Carolina State University, Raleigh, N.C.). *Applied Physics Letters*, vol. 34, Jan. 1, 1979, p. 38, 39. Research supported by the U.S. Department of Energy.

A two-junction cascade solar-cell structure has been demonstrated in the AlGaAs/GaAs materials system. The cell consists of two p-n junctions with different band gaps monolithically connected in series by means of a low-resistance p-n junction. An open-circuit voltage of 2.0 V has been observed for this cascade structure. This is the highest open-circuit voltage that has been reported for a single monolithic photovoltaic cell. (Author)

**A79-22858** Microstructure dependence of the optical properties of solar-absorbing black chrome. A. Ignatiev, P. O'Neill, C. Doland, and G. Zajac (Houston, University, Houston, Tex.). *Applied Physics Letters*, vol. 34, Jan. 1, 1979, p. 42-44. 15 refs. Research supported by the U.S. Department of Energy.

The surface microstructure and chemical constituency of solar-absorbing black chrome films have been studied by scanning electron microscopy (SEM), X-ray photoemission spectroscopy (XPS), and sputter depth-profiling techniques. The films have been determined to consist of a top layer of small (about 400 Å) Cr<sub>2</sub>O<sub>3</sub> particles with one or two sublayers of larger (about 1000 Å) closely packed chromium particles. In addition, it has been shown that the optical response of the particulate black chrome films is significantly determined by the microstructure of the films. (Author)

**A79-22859** Explanation for low-efficiency Cu<sub>2</sub>O Schottky-barrier solar cells. L. C. Olsen, R. C. Bohara (Joint Center for Graduate Study, Richland, Wash.), and M. W. Urie (Hanford Engineering Development Laboratory, Richland, Wash.). *Applied*

*Physics Letters*, vol. 34, Jan. 1, 1979, p. 47-49. NSF Grant No. AER-75-20501.

Surface analyses combined with barrier-height studies indicate that Cu<sub>2</sub>O Schottky barriers made with low-work-function metals (Yb, Mg, and Mn) are essentially Cu/Cu<sub>2</sub>O cells due to reduction of the Cu<sub>2</sub>O surface and subsequent interdiffusion phenomena. The copper-rich region essentially determines the barrier height. As a result, efficiencies of Cu<sub>2</sub>O Schottky-barrier solar cells are usually less than 1%. It is concluded that to achieve significant increases in Cu<sub>2</sub>O cell efficiencies, MIS or heterojunction device structures must be utilized. (Author)

**A79-22862** Performance of a new high-intensity silicon solar cell. R. I. Frank and R. Kaplow (MIT, Cambridge, Mass.). *Applied Physics Letters*, vol. 34, Jan. 1, 1979, p. 65-67. 6 refs. Research supported by the National Patent Development Corp.

A new silicon solar cell, designed to have improved electrical, optical and thermal transfer characteristics at very high incident light intensities, has been fabricated and provides experimental verification of the basic design concepts. The AMI efficiency for nonoptimized cells is 12.8% at 25 C. At 300 suns the efficiency increases to 19%. It is shown that efficiencies of over 25% are possible for this type of cell in a more-optimized form at intensities of about 500-1000 suns. (Author)

**A79-22923** A theoretical study of wood gasification processes. W. J. Cousins (Department of Scientific and Industrial Research, Physics and Engineering Laboratory, Lower Hutt, New Zealand). *New Zealand Journal of Science*, vol. 21, June 1978, p. 175-183. 14 refs.

A thermodynamic theory that has been used successfully for many years to describe the gasification of coal is applied to the gasification of wood. Some modification of the theory is necessary to allow for the very high production of volatiles during the pyrolysis of wood. The use of the modified theory is illustrated by application to countercurrent and cocurrent gasification of wood with air/steam and oxygen/steam blasts. (Author)

**A79-22924** Wind power site evaluation. I - Wind energy potential. II - Data acquisition and processing. R. J. Clegg, M. D. Johns, and S. W. Pattemore (Auckland, University, Auckland, New Zealand). *New Zealand Journal of Science*, vol. 21, June 1978, p. 185-193; 195-204. 11 refs. Research supported by the University Grants Committee of New Zealand and University of Auckland.

A field station on the Whangaparaoa peninsula in New Zealand has provided data on wind speed and direction for a 12 month period. Data covering a six month period have been used to determine the wind power potential of the site. Analysis shows that the site has a mean wind energy flux of 464 W/sq m at a height of 10 m for the six month period; the estimate for the full year is 371 W/sq m. In addition, some aspects of the acquisition and processing of data relating to wind power site evaluation are discussed in detail. The effect of wind speed sampling intervals on the accuracy of wind power estimates was measured and some alternative methods of calculating wind power from the wind speed data were investigated. B.J.

**A79-22925** Mercury in some New Zealand geothermal discharges. B. G. Weissberg and A. G. Rohde (Department of Scientific and Industrial Research, Chemistry Div., Lower Hutt, New Zealand). *New Zealand Journal of Science*, vol. 21, Sept. 1978, p. 365-369. 20 refs.

Mercury concentrations in the discharges from some New Zealand geothermal wells range from 1.0 to 61 micrograms Hg/kg of steam separated from water between 0.7 and 14 bar pressure (gauge), and from 0.02 to 0.12 micrograms Hg/kg of water separated from steam at atmospheric pressure. The concentration of mercury in the steam phase implies the presence of volatile mercury species such as elemental mercury, mercurous chloride, or organic mercury compounds in the geothermal fluid at depth. The total mercury added to

the Waikato River from the Wairakei geothermal scheme is about 55 kg of mercury per year or an average increment of 0.015 micrograms Hg/kg of river water. Although this is well below the limit recommended by the World Health Organization of 1.0 micrograms Hg/kg for mercury in potable water, the mercury may accumulate in sediments along with mercury from natural geothermal activity and other sources and contaminate fish after microbiological methylation. (Author)

**A79-22977** # Single-particle behaviour in plasmas. B. McNamara (California, University, Livermore, Calif.). In: Theoretical and computational plasma physics; College, Trieste, Italy, March 22-April 9, 1977, Selected Lectures. Vienna, International Atomic Energy Agency, 1978, p. 5-25. 22 refs. Contract No. W-7405-eng-48.

The paper is a collection of the essential formulas and mathematical techniques for dealing with the motion of charged particles in electromagnetic fields as it applies to plasmas. The various useful forms of the method of averaging are displayed and applied to the calculation of constants of motion. The breakdown of these constants is discussed along with some of the implications for fusion systems. A theory of invariants is described that first shows how to average over a single frequency. Then it is modified to take into account the multifrequency case, where beats can produce a slow variation. The method is illustrated by a calculation of orbits for a charged particle in a uniform magnetic field interacting with an electrostatic plasma wave. P.T.H.

**A79-22979** # Equilibrium relations in the presence of arbitrary plasma diffusion in axisymmetric configurations. D. Pfirsch (Max-Planck-Institut für Plasmaphysik, Garching, West Germany). In: Theoretical and computational plasma physics; College, Trieste, Italy, March 22-April 9, 1977, Selected Lectures. Vienna, International Atomic Energy Agency, 1978, p. 49-58. EURATOM-sponsored research.

A condition for general axisymmetric diffusive equilibria that relates the outward diffusion to the toroidal current density is derived. In an approximation version, it requires that some effective diffusion velocity must not exceed the poloidal magnetic diffusion velocity. Relevant consequences follow in the anomalous diffusion regime if diffusion is caused by an anomalous parallel electron viscosity instead of an anomalous perpendicular resistivity. In the former case, the effective diffusion velocity equals the real diffusion velocity, and an anomalous bootstrap current arises which leads to rather low upper limits for the poloidal beta. If the usual trapped ion or Bohm diffusion is assumed to be caused by enhanced viscosity, no stationary high-temperature equilibria would be possible in a system governed by the appropriate diffusion law. (Author)

**A79-22980** # Collisional transport. D. Pfirsch (Max-Planck-Institut für Plasmaphysik, Garching, West Germany). In: Theoretical and computational plasma physics; College, Trieste, Italy, March 22-April 9, 1977, Selected Lectures. Vienna, International Atomic Energy Agency, 1978, p. 59-76. 11 refs.

Collisional particle and heat transport is treated in plane and toroidal geometry. In particular, temperature gradient effects on impurity diffusion - so-called temperature screening - are considered for the different collisional regimes. The existence of quasistationary self-consistent tokamak equilibria with finite resistivity and a possible limitation of the maximum beta caused by particle diffusion is discussed. (Author)

**A79-22981** # Non-linear numerical algorithms for studying tearing modes. B. V. Waddell, M. N. Rosenbluth (Institute for Advanced Study, Princeton, N.J.), D. A. Monticello, R. B. White (Princeton University, Princeton, N.J.), and B. Carreras. In: Theoretical and computational plasma physics; College, Trieste, Italy, March 22-April 9, 1977, Selected Lectures. Vienna, International Atomic Energy Agency, 1978, p. 79-91. 9 refs. ERDA-sponsored research.



The numerical methods that have recently been developed to study the nonlinear evolution of tearing modes in tokamaks are summarized. The essential features of tearing modes can be described by the resistive MHD equations. The numerical algorithms described here are based on a reduced set of two-dimensional resistive MHD equations that are numerically tractable. Two distinct types of numerical methods are described in detail. In the first method, referred to as the MASSLESS algorithm, the inertia is neglected. On the other hand, in the second method, referred to as the MASS algorithm, the inertia is retained and consequently the scheme is capable of handling a larger variety of problems. Codes based on these two algorithms give similar results for the nonlinear evolution of the  $m = 2$  tearing mode. (Author)

**A79-23027** Prepulse damage to targets and alignment verification. R. F. Benjamin and G. T. Schappert (California, University, Los Alamos, N. Mex.). *Journal of Applied Physics*, vol. 50, Jan. 1979, p. 7-10. 16 refs. Research sponsored by the U.S. Department of Energy.

The damage threshold of 10.6-micron light incident on glass microballoon laser fusion targets has been measured. The threshold is several dozen microjoules, depending on target size and laser pulse width, and the damage mechanism appears to be thermal heating and rupture. Perforating glass microballoons proves to be a useful alignment verification technique. (Author)

**A79-23034** Fuel content characterization and pressure retention measurements of DT-filled laser fusion microballoon targets. H. W. Deckman and G. M. Halpern (Exxon Research and Engineering Co., Linden, N.J.). *Journal of Applied Physics*, vol. 50, Jan. 1979, p. 132-139. 18 refs. Research supported by the University of Rochester.

A nondestructive assay of the fuel content of deuterium-tritium (DT)-filled microballoon laser fusion targets has been developed which is based on beta-particle counting rates. By using a model employing transmission measurements of kilovolt electrons through thin films, observed count rates are correlated with the amount of tritium in the glass walls and hollow interior of the microballoons. This assay technique is primarily applicable for balloons with glass wall thicknesses of less than 1.5 microns, where the number of escaping beta particles is large compared with the number of X-ray photons generated in the glass, and has been applied to measure the pressure-retention characteristics of individual targets. At room temperature the balloons exhibited widely diverse and rapid leakage rates which could not be correlated with a model based on molecular diffusion and the assumption that all balloons had a homogeneous composition. Cryogenic storage greatly reduced the leakage rates with pressure-retention half-lives ranging from 5 to approximately 12 years. (Author)

**A79-23039** The interfacial layer in MIS amorphous silicon solar cells. J. McGill, J. I. B. Wilson (Heriot-Watt University, Edinburgh, Scotland), and S. Kinmond (Dundee, University, Dundee, Scotland). *Journal of Applied Physics*, vol. 50, Jan. 1979, p. 548-550. 22 refs. Research supported by the Science Research Council and EEC.

When an insulating layer of  $\text{TiO}_x$  is added beneath the Ni barrier contact of amorphous silicon Schottky diodes, increases are produced in both the open-circuit voltage and the short-circuit current. The former change is explained by an increased barrier height and diode factor, and the latter change is at least partially caused by an increase in the width of the space-charge region. (Author)

**A79-23125** Optimizing the conversion mode for solar energy. Iu. V. Mitishkin. (*Avtomatika i Telemekhanika*, July 1978, p. 53-60.) *Automation and Remote Control*, vol. 39, no. 7, Dec. 10, 1978, p. 980-985. 8 refs. Translation.

Consideration is given to the automatic optimization of the operation of a solar energy converter (solar array, solar thermoelectric generator, etc.) in autonomous power-supply systems. The process of search for maximum power extracted from the converter

by means of a pulsed automatic optimizer is investigated. A dc-converter with parallel switch is used in the power circuit of the optimizer. B.J.

**A79-23137** Dynamic characteristics of a free-piston diesel engine combined with a MHD generator. B. M. Antonov, V. A. Bashkatov, Iu. M. Kirillov, I. N. Postnikova, S. S. Safonova, and E. E. Shpil'rain (Akademiia Nauk SSSR, Nauchno-Issledovatel'skii Institut Vysokikh Temperatur, Moscow, USSR). (*Teplotfizika Vysokikh Temperatur*, vol. 16, May-June 1978, p. 611-619.) *High Temperature*, vol. 16, no. 3, Nov. 1978, p. 519-526. 5 refs. Translation.

The paper proposes a method for calculating the dynamic characteristics of a system consisting of a free-piston diesel engine and a liquid-metal MHD generator. Results of the computation of the dynamic, thermodynamic and cost-efficiency characteristics of the system are presented for the following initial conditions: independent excitation, a channel induction of 2 T, active electrical loading, a load coefficient of 0.95, a rectangular cross section of the MHD channel of 5 mm x 20 mm, and three different piston areas, 312, 467, and 623 sq mm. B.J.

**A79-23138** Construction of a mathematical model for MHD generator electrodes in the arc regime of operation. L. P. Poberezhskii (VNIIPtransprogress, USSR). (*Teplotfizika Vysokikh Temperatur*, vol. 16, May-June 1978, p. 620-623.) *High Temperature*, vol. 16, no. 3, Nov. 1978, p. 527-530. 12 refs. Translation.

**A79-23280** Mining earth's heat - Hot dry rock geothermal energy. R. G. Cummings, G. E. Morris, J. W. Tester, and R. L. Bivins (California, University, Los Alamos, N. Mex.). *Technology Review*, vol. 81, Feb. 1979, p. 58-74, 78. 32 refs. Research supported by the U.S. Department of Energy.

It is estimated that energy amounting to 13,000,000 quads are contained in crustal rock to a depth of ten km in the U.S. The technology of HDR (Hot Dry Rock Geothermal Energy) is discussed, together with an assessment of size and quality of HDR resource, as well as of extraction approaches and problems of containment and recovery, emphasizing variations in reservoir design, operating parameter values, and financial and regulatory criteria. A model of a geothermal power plant is presented, noting that the selection of optimum plant design conditions becomes more complex as reservoir temperature declines. The base-case parameter values used in the optimization model to evaluate HDR energy for production of electricity are given, including life of the system (30 years), electric plant capacity (50 MW(e)), maximum well flow rate (75 kg/sec), geothermal gradient (40 C/km), busbar price of electricity (3 cents/kWh), and operation and maintenance costs (0.13 cents/kWh). It is concluded that if busbar costs are at the high end, a considerable incentive for HDR development would exist. A.A.

**A79-23295** Prediction of the behavior of a solar storage system by means of recurrent stochastic models (Prévision du comportement d'un système de stockage solaire à l'aide de modèles stochastiques récurrents). C. Bénard, Y. Body (CNRS, Paris, France), A. Wirgin (Paris VI, Université, Paris, France), and D. Gobin (Ecole Centrale des Arts et Manufactures, Châtenay-Malabry, Hauts-de-Seine, France). *La Météorologie*, Sept. 1978, p. 69-80. In French.

Procedures for constructing a recurrent stochastic model of solar energy storage are described, and two rough linear models, the W model and the B model, are presented. The models differ in the assumptions of loss and energy characteristics but produce similar results. Data on the a priori probability of good functioning of storage systems are presented for different assumed conditions. M.L.

**A79-23306** Wave-tank experiments on an immersed parallel-plate duct. G. F. Knott and J. O. Flower (Sussex, University, Brighton, England). *Journal of Fluid Mechanics*, vol. 90, Jan. 29, 1979, p. 327-336. Research supported by the Science Research Council.

The paper reports on some experiments performed on a fully submerged parallel-plate duct structure that oscillates in response to wave-induced pressures at its opening. Amplitude and phase of the direct and reflected wave trains on both sides of the duct were deduced, and measurements of the oscillating pressure in the enclosure were made. From these one calculated the pressure amplification ratio and the duct reflection coefficient. These preliminary experiments showed that the theory is fairly accurate and that appreciable amplification of duct pressures is possible, which is of importance for immersed pressure-driven wave-energy devices. P.T.H.

**A79-23307** A theory for wave-power absorption by two independently oscillating bodies. M. A. Srokosz and D. V. Evans (Bristol, University, Bristol, England). *Journal of Fluid Mechanics*, vol. 90, Jan. 29, 1979, p. 337-362. 22 refs. Research supported by the Science Research Council.

The paper gives a linear analysis of the problem of two arbitrary cylinders oscillating independently and capable of absorbing energy in a single mode from a given incident wave. It is shown how the general problem can be regarded as the superposition of the solution to the scattering problem in which the cylinders are held fixed in the incident wave, and the solution to the radiation problem in which each cylinder makes forced oscillations in turn, the other cylinder being held fixed, in the absence of the incident wave. It is shown that for a certain displacement of the cylinders, 100% wave-energy absorption efficiency is possible. An approximate method is presented for solving the radiation and scattering problems for two cylinders in terms of the solution for one cylinder. P.T.H.

**A79-23343** Photoelectrolysis of water with semiconductors. M. Tomkiewicz and H. Fay (Union Carbide Corp., Medical Products Div., Tarrytown, N.Y.). *Applied Physics*, vol. 18, Jan. 1979, p. 1-28. 149 refs.

The use of semiconductors as photoelectrodes in electrolytic cells is described and results reported in the literature for various semiconductors are reviewed. The most important properties of the semiconductor in this process are found to be the band-gap energy and the flat-band potential. For electrolysis to proceed, the potential corresponding to the band gap must appreciably exceed the standard potential for the electrolysis of water, 1.23 V. In addition, the flat-band potential must be more negative than the hydrogen potential or an external bias voltage is required. The use of solar energy in this process is considered and a general discussion is presented of the practical prospects of photoelectrolysis in comparison with solid state solar cells. B.J.

**A79-23458** East Mesa geothermal test site. W. A. Fernelius (U.S. Bureau of Reclamation, Div. of Planning, Boulder City, Nev.) and M. K. Fulcher (U.S. Bureau of Reclamation, Boulder City, Nev.). (*American Society of Civil Engineers, Annual Convention, Exposition and Continuing Program, San Francisco, Calif., Oct. 17-21, 1977.*) *American Society of Civil Engineers, Environmental Engineering Division, Journal*, vol. 105, Feb. 1979, p. 13-32. 5 refs.

The activities of the Bureau of Reclamation at East Mesa (California) Test Site and the results of its geothermal desalting program are described. Data on location, geothermal characteristics, and results of the chemical analysis of East Mesa geothermal wells are presented. Investigations including direct contact heat exchanger experiments, and energy conversion systems are mentioned, as are the well interference tests using highly sensitive electronic pressure gauges (over 0.01 psi). Injection operations are discussed, and it is found that wellhead silica concentrations appear to be related to flow rate. A seismic monitoring system, and a subsidence monitoring system, are outlined. The Multistage Flash (MSF), Vertical Tube Evaporator (VTE), and High Temperature Electrodialysis (HTED) desalting systems are discussed in detail. It is concluded that the systems have shown the capability to desalt geothermal fluid, and problems associated with each have been identified together with probable solutions. A.A.

**A79-23581** \* Dynamic simulation studies of fuel conservation procedures used in terminal areas. P. J. O'Brien (FAA, National Aviation Facilities Experimental Center, Atlantic City, N.J.), L. Tobias, and E. A. Palmer (NASA, Ames Research Center, Moffett Field, Calif.). In: *Air Traffic Control Association, Annual Fall Conference, 23rd, Fort Worth, Tex., October 2-5, 1978, Proceedings*. Washington, D.C., Air Traffic Control Association, Inc., 1978, p. 9-15.

A simulation program was devised to study the effects of fuel conservation procedures on ATC and terminal area operations. The FAA National Aviation Facilities Experimental Center and the Ames Research Center have interconnected ATC and piloted simulation facilities at both centers. A unique national simulation facility for the study of pilot/controller/system interactions was established. The present paper describes the simulation facilities and outlines aircraft operational procedures evaluated in the experiments. Two experiments studied are discussed: the first involves two types of landing approaches, while the second involves both landing approaches and profile descents. B.J.

**A79-23599** MHD instabilities. G. Bateman. Cambridge, Mass., MIT Press, 1978. 270 p. 285 refs. \$22.50.

The MHD equations are considered along with the Rayleigh-Taylor instability, linearized equations and the energy principle, toroidal instabilities, high beta tokamaks, nonlinear instability theory, resistive instabilities, and a comparison between theory and experiment. The characteristics of the MHD equilibrium are examined, taking into account force balance equations, surface quantities, the q-value, the Grad-Shafranov equation, an example of bifurcation related to a cylinder with elongated cross section, a plasma squeezed between conducting walls, and the tokamak equilibrium. Circular cylinder instabilities are also investigated, giving attention to aspects of equilibrium, the physical picture of current driven instabilities, the 1-D eigenvalue equation, the 1-D energy principle, fixed-boundary instabilities, and free-boundary instabilities. G.R.

**A79-23600** # A planning and information system for strategic energy policy assessment. S. Hannus. Research supported by the Finnish Cultural Foundation and Technological Foundation. Helsinki, Kyriiri Oy, 1978. 161 p. 22 refs.

A quantitative planning and information system for strategic energy policy assessment is constructed. The purpose is not to model the energy system but to arrange knowledge of the system into a useful form. The energy system is analyzed, and the information system, which includes an information processing component with four separate data processing systems and the planning data base, is described. Validation of the system is considered, and two scenarios for the future, one a crisis scenario, are examined. The design, construction, application, and evaluation of the information system are discussed. M.L.

**A79-23603** International Conference on Thermoelectric Energy Conversion, 2nd, University of Texas, Arlington, Tex., March 22-24, 1978, Proceedings and Supplement. Conference sponsored by the Institute of Electrical and Electronics Engineers and University of Texas. Edited by K. R. Rao. New York, Institute of Electrical and Electronics Engineers, Inc., 1978. Proceedings, 142 p.; Supplement, 17 p. \$30.

Papers are presented on thermoelectric (TE) materials and properties, novel applications and analysis of TE devices, TE systems design, and TE generators. Particular consideration is given to such topics as the comprehensive thermoelectric behavior of selected n-type and p-type silicon-germanium alloy, design concepts of solar thermoelectric generators in space applications, estimation of heat loads in multistage thermoelectric coolers, reversible thermoelectric power conversion of energy fluctuations, and regenerative burner systems for thermoelectric power sources. B.J.

**A79-23604** \* Comprehensive thermoelectric properties of n- and p-type 78a/o Si - 22a/o Ge alloy. V. Raag (Synical Corp.,

Sunnyvale, Calif.). In: International Conference on Thermoelectric Energy Conversion, 2nd, Arlington, Tex., March 22-24, 1978, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p. 5-10. Contract No. NAS7-100.

The time and temperature dependence of the thermoelectric properties on n- and p-type 78 a/o Si - 22 a/o Ge alloy are presented in detail for the range of temperatures of zero to 1000 C and operating times up to twelve years. The mechanisms responsible for the time dependence of the properties are discussed and mathematical models used in the derivation of the property values from experimental data are presented. The thermoelectric properties for each polarity type of the alloy are presented as a function of temperature for various operating times. (Author)

**A79-23609** On an irreversible thermodynamic analysis of thermoelectric devices. O. A. Arnas (Louisiana State University, Baton Rouge, La.) and D. L. Miller. In: International Conference on Thermoelectric Energy Conversion, 2nd, Arlington, Tex., March 22-24, 1978, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p. 36-40. Research supported by the Olin Corp.; NSF Grant No. EPP-75-04148.

Irreversible thermodynamics attempts to describe dynamic state changes in thermoelectric materials through the derivation of an entropy balance equation which equates physical processes to the respective changes in entropy. A unified energy theory of thermoelectric behavior is derived on the basis of conservation equations, phenomenological laws, the Curie principle, and the Onsager relations. The approach is used to analyze a thermoelectric generator, and methods of calculating the power output of this device are suggested. B.J.

**A79-23612 \*** Design concepts of solar thermoelectric generators in space applications. V. Raag, L. Hankins (Synal Corp., Sunnyvale, Calif.), and M. Swerdling (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In: International Conference on Thermoelectric Energy Conversion, 2nd, Arlington, Tex., March 22-24, 1978, Proceedings.

New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p. 60-65. Contract No. NAS7-100.

Several thermoelectric technologies have been examined as to their suitability for use in a solar thermoelectric generator (STG) as a nonpropulsive power source for space applications. The results show that of all the presently available thermoelectric technologies, i.e., lead telluride, bismuth telluride, selenide, and silicon-germanium alloys, the latter type provides the optimum STG. Detailed results are presented on the performance and configurational characteristics of various silicon-germanium alloy STGs, including the performance of such STGs as a function of time in a Mercury orbit and the orbit of Mercury around the sun. It is shown that an STG design based on the use of silicon germanium alloy thermoelectric material, using multiple high voltage thermopiles with individual solar concentrators, presents the optimum combination of technology and configuration for minimizing power source mass. Additional concepts studied and discussed are the flat plate individual thermopile type and single concentrator compact thermopile type. The STG possesses an attractive potential for this application and represents a useful addition to the family of power sources for consideration in various space applications. (Author)

**A79-23613** Optimization method of isotopic thermoelectric microgenerator geometry. T. Wartanowicz and J. Zembrzki (Warszawa, Politechnika, Warsaw, Poland). In: International Conference on Thermoelectric Energy Conversion, 2nd, Arlington, Tex., March 22-24, 1978, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p. 66-71.

The subject of the analysis is a microgenerator, i.e. a generator having a power output under 500 mW. The generator geometry optimization is based on the isotopic source thermal power minimization for its given rated electric parameters, i.e. power and voltage.

The optimization procedure makes it possible to present graphically the results of calculations. (Author)

**A79-23614** Estimating heat loads on multistage thermoelectric heat pumps. R. Marlow and P. B. Click, Jr. (Marlow Industries, Inc., Garland, Tex.). In: International Conference on Thermoelectric Energy Conversion, 2nd, Arlington, Tex., March 22-24, 1978, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p. 72-81.

To optimize the design of a thermoelectric heat pump for minimum input power, it is necessary to make a good estimate of the heat load. Multistage thermoelectric heat pumps are required to cool temperature sensitive components to 233 K or colder. In these cases the relationship of coefficient of performance, vs cold side temperature indicates that any small error in the heat load calculation is reflected as a large error in input power. The relationship of heat load and input power relative to cold side temperature is discussed in this paper. Graphical presentations are used to estimate the heat loads for these examples and to show the effect on input power. Typical examples are as follows: (1) cooling of a multielement infrared detector array to 193 K, (2) cooling of a single element silicon laser sensor to a temperature of 163 K, (3) cooling a self scanned array chip to 233 K in xenon. Each example has specific problems in evaluating heat load and input power requirements. (Author)

**A79-23615** Method of producing a p-type or n-type alloy for direct thermoelectric energy conversion. M. C. Nicolau (Santander, Universidad Industrial, Bucaramanga, Colombia). In: International Conference on Thermoelectric Energy Conversion, 2nd, Arlington, Tex., March 22-24, 1978, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p. 82-85. 24 refs.

**A79-23616** Some effects of leg surface heat losses on the performance of a p-n type thermoelectric generator. E. F. Thacher and M. H. Cobble (New Mexico State University, Las Cruces, N. Mex.). In: International Conference on Thermoelectric Energy Conversion, 2nd, Arlington, Tex., March 22-24, 1978, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p. 86-89.

A preliminary analysis of the effects of leg surface heat loss on the transient and steady-state performance of a thermoelectric generator was performed for the case of a constant and uniform overall heat transfer coefficient applied to the leg surfaces, temperature dependent material properties (except for density and specific heat), and constant hot and cold shoe temperatures. The results are that as the heat transfer coefficient is increased the leg temperature distributions become markedly non-linear, the internal resistance decreases, the output power and current increases slightly, the input power increases, the time to equilibrium decreases, and the efficiency decreases. (Author)

**A79-23618** Efficiency of a series of thermoelectric generators in a solar wedge concentrator. M. H. Cobble (New Mexico State University, Las Cruces, N. Mex.). In: International Conference on Thermoelectric Energy Conversion, 2nd, Arlington, Tex., March 22-24, 1978, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p. 100-103.

A system for generating electrical power from solar energy utilizing a non-tracking wedge to concentrate sunlight onto a series of M thermoelectric generators, cooled by a heat exchanger, is analyzed. Expressions are developed for the temperature distribution in the p and n legs, and for the temperatures of the hot junctions and, cold junctions and the temperature distribution in the fluid, the electrical work efficiency and the efficiency of heating the cooling fluid. The wedge concentration is given as a function of the wedge 1/2 angle, and the included angle of incidence. Utilizing the theory in an example, the electrical work efficiency and fluid heating

efficiency are shown plotted against concentration and mass flow rate in separate figures. Additionally the temperature distribution in the hot plate junctions, cold plate junctions and in the cooling fluid are plotted vs. distance for a typical problem. (Author)

**A79-23619** Reversible thermoelectric power conversion of energy fluctuations. J. C. Yater (Energy Unlimited, Inc., Lincoln, Mass.). In: International Conference on Thermoelectric Energy Conversion, 2nd, Arlington, Tex., March 22-24, 1978, Proceedings.

New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p. 107-114. 17 refs. Research supported by the U.S. Department of Energy.

The results of an analysis of an independent particle model for both classical and quantum effects show that a reversible thermoelectric converter with power conversion of energy fluctuations has the potential of achieving the maximum efficiency of the Carnot cycle. The device utilizes the electric fluctuation energy of small circuits at a different temperature so as to produce useful energy and can efficiently pump heat from lower to higher temperatures. Several applications of this device are described including earth solar power, steam power plants, topping and tailing, space solar power stations, and heat pumps or refrigerators. B.J.

**A79-23621** Regenerative burner system for thermoelectric power sources. G. Guazzoni, J. Angello, and A. Herchakowski (U.S. Army, Electronics Technology and Devices Laboratory, Fort Monmouth, N.J.). In: International Conference on Thermoelectric Energy Conversion, 2nd, Arlington, Tex., March 22-24, 1978, Proceedings.

New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p. 121-125.

A thermoelectric power source is being developed to provide a multifuel, silent, maintenance free tactical power generator for forward area applications. Formal testing of prototype models of the 500-Watt Thermoelectric Power Source has demonstrated its ability as an improved source of power for military equipment in a wide range of environmental conditions. This unit will replace the troublesome gasoline engine-driven generator sets which are noisy, unreliable, and require frequent maintenance. Maximum efficiency during operation of the thermoelectric power source will assure an effective utilization of fossil fuel in support of Army mission requirements and energy conservation. Test results not only show significant reduction in fuel consumption, but also indicate that preheating of the primary air for combustion provides a practical solution for the elimination of carbon accumulation in the burner system. (Author)

**A79-23622** # Determining the reliability of radioisotope thermoelectric generators (RTGs) designed for terrestrial and undersea applications. F. E. Rosell, Jr. (Defense Systems Management College, Fort Belvoir, Va.) and J. F. Vogt (U.S. Navy, Naval Nuclear Power Unit, Port Hueneme, Calif.). In: International Conference on Thermoelectric Energy Conversion, 2nd, Arlington, Tex., March 22-24, 1978, Supplement.

New York, Institute of Electrical and Electronics Engineers, Inc., 1978, 7 p.

Field experience with RTG power sources in harsh environments is reviewed with attention given to the use of RTGs for oceanographic sensors, in meteorological stations, and in undersea structures. Particular attention is given to the reliability determination of RTGs on the basis of accelerated testing and some recommendations for improving the reliability of RTGs, particularly of the plutonium-238-fueled half-watt type, are presented. B.J.

**A79-23623** # Recent terrestrial and undersea applications of radioisotope thermoelectric generators (RTGs). F. E. Rosell, Jr. (Defense Systems Management College, Fort Belvoir, Va.) and J. F. Vogt (U.S. Navy, Naval Nuclear Power Unit, Port Hueneme, Calif.). In: International Conference on Thermoelectric Energy Conversion, 2nd, Arlington, Tex., March 22-24, 1978, Supplement.

New York, Institute of Electrical and Electronics Engineers, Inc., 1978, 5 p.

This paper discusses recent projects utilizing strontium-90 RTGs under diverse conditions at various global locations, and covers

progress on the Navy's plutonium-fueled superbattery. The purpose of this paper is to demonstrate that RTGs provide practical, reliable sources of power for many types of applications for electronic systems in inaccessible locations, and to discuss some of the problems encountered in these applications. (Author)

**A79-23624** # Stability of work and sensitivity of semiconductor thermoelectric systems under automatic control. A. G. Makhlin (Unimation, Inc., Danbury, Conn.). In: International Conference on Thermoelectric Energy Conversion, 2nd, Arlington, Tex., March 22-24, 1978, Supplement.

New York, Institute of Electrical and Electronics Engineers, Inc., 1978, 4 p.

Some theoretical considerations on the selection of a controller for temperature control by means of a thermoelectric heat pump are presented. The selection is made on the basis of the transient response and dynamic characteristics of the thermoelectric battery, and a transfer function for the battery is obtained and analyzed. An analysis of the self-oscillating operating mode shows that the two-position controller provides the necessary quality of control for a thermoelectric air-to-air type heat pump. B.J.

**A79-23640** Emissions from pressurized fluidized-bed combustion processes. K. S. Murthy, J. E. Howes, H. Nack (Battelle Columbus Laboratories, Columbus, Ohio), and R. C. Hoke (Exxon Research and Engineering Co., Linden, N.J.). *Environmental Science and Technology*, vol. 13, Feb. 1979, p. 197-204.

The results of a comprehensive analysis of emissions from a pressurized fluidized-bed combustion (FBC) unit are presented. The analysis comprised approximately 740 measurements on about 90 samples from nine streams, including coal feed, dolomite feed, second stage cyclone discard, bed reject material, undiluted stack gas, diluted stack gas, cyclone discharge leachates, bed reject material leachates, and dilution and combustion air. A brief discussion of the sampling methods and analytical techniques is given. Major conclusions are (1) comprehensive analysis of emissions from emerging energy technologies yields useful results for environmental assessment of the processes; (2) pressurized coal-burning FBC units can meet existing new source performance standards for SO<sub>2</sub> and NO<sub>x</sub> emissions from coal-fired steam generators; and (3) minimum acute toxicity effluent standards for SO<sub>2</sub>, NO<sub>x</sub>, and CO need reevaluation. P.T.H.

**A79-23710** High-efficiency AlGaAs/GaAs concentrator solar cells. R. Sahai, D. D. Edwall, and J. S. Harris, Jr. (Rockwell International Science Center, Thousand Oaks, Calif.). *Applied Physics Letters*, vol. 34, Jan. 15, 1979, p. 147-149. 9 refs.

Efficiencies of 25% have been obtained with 1-cm-diam AlGaAs/GaAs heteroface concentrator solar cells utilizing an ultrathin AlGaAs window layer design. A low specific resistance (greater than 0.005 ohm-sq cm) Ohmic contact is achieved by direct contact to the p-GaAs active layer. Liquid phase epitaxy has been developed to grow (greater than 500 Å) thick window layers on large-area (3.3 x 3.3 cm) GaAs substrates. Four 1-cm-diam cells are produced from each wafer and demonstrate the potential for larger-scale production. (Author)

**A79-23718** Energy storage efficiency for the ammonia/hydrogen-nitrogen thermochemical energy transfer system. O. M. Williams and P. O. Carden (Australian National University, Canberra, Australia). *International Journal of Energy Research*, vol. 3, Jan-Mar. 1979, p. 29-40. 10 refs.

The method used to calculate the energy storage efficiency for the solar thermochemical energy transfer system based on ammonia/hydrogen-nitrogen is described. A criterion that the correct value of separation work for a two-phase mixture must be generated internally by degradation of mixing heat is adopted, and thermodynamic data are generated from available phase equilibrium measurements with application of the criterion. Energy storage efficiencies are shown to increase towards unity as the endothermic reaction approaches completion; efficiencies greater than 0.90 are obtained for reaction extents exceeding 0.60. The analysis is

supported by a comparison of analytic results with experimental results. M.L.

**A79-23719** Synthetic oil from coal - The economic impact of five alternatives for making hydrogen from coal and steam. H. F. Moore, E. T. Kim, and R. I. Kermode (Kentucky, University, Lexington, Ky.). *International Journal of Energy Research*, vol. 3, Jan.-Mar. 1979, p. 41-57. 16 refs. Research supported by the Institute for Mining and Minerals Research and Ashland Oil Co.; NSF Grant No. AER-73-0359-A02.

The economics of liquefying coal by catalytic hydrogenation have been examined for five cases. The first three cases determined the effect upon the cost of syn crude of producing a syngas from coal and steam suitable for making hydrogen at pressures of 44.7 psia, 500 psia and 1000 psia. In the fourth case a carbonization step was included which produced a char suitable for gasification and a liquid product which was upgraded to a syn crude consuming 2000 SCF of hydrogen per bbl. In the last case all of the coal was liquefied and a vacuum bottoms material gasified to produce hydrogen. For all five cases the cost of syn crude was calculated using discounted cash flow (DCF) rates of 10, 15, and 20 per cent coal costs of \$10, \$20, \$30 and \$40 per ton, and several methods of by-product fuel valuation. Sensitivity analysis was performed on the operating costs, plant life, operating attainment schedule, and method of financing. Finally, a cost comparison between syn crude and natural World oil in the years 1985 and 1990, assuming yearly inflation rates of 5 and 10 per cent, has been made. (Author)

**A79-23721** Synthetic chloroplasts. M. Calvin (California, University, Berkeley, Calif.). (International Symposium on Chloroplast Development, Spetsai, Greece, July 15-19, 1978.) *International Journal of Energy Research*, vol. 3, Jan.-Mar. 1979, p. 73-87. 25 refs. Research sponsored by the U.S. Department of Energy.

The development of synthetic chloroplasts is discussed, and natural and synthetic chloroplast characteristics are examined. While the proposed synthetic chloroplasts will contain no protein, the synthetic chloroplast system will mimic the way in which the green plant takes (four) quanta to generate oxygen on one side and reducing power on the other side of the membrane. The photo-induced electron transfer from a porphyrin in a micelle to a quinone in aqueous solution has been demonstrated directly, and future steps in the development of the synthetic chloroplast are indicated. M.L.

**A79-23751** Structuring a small national or state solar energy program. W. H. Jones (West Florida, University, Pensacola, Fla.) and M. M. Yarosh (Florida Solar Energy Center, Cape Canaveral, Fla.). (International Solar Energy Society, Annual Meeting, New Delhi, India, Jan. 15-21, 1978.) *Solar Energy*, vol. 22, no. 1, 1979, p. 1-7. 14 refs.

The methodology developed for structuring a state solar energy plan consisted in conducting an analysis of energy end-use patterns, reviewing these patterns in terms of available solar technologies, selecting the most promising technologies, and modifying the results by incorporation of a number of relevant social, economic, and political communities of interest. The paper describes the application of this methodology to the case of Florida's solar energy program. End-use analysis showed that Florida's energy problems would be best met by development of relatively low temperature solar energy methods for heating and air conditioning, while solar electric technology is not of interest to Florida. A systems analysis for the Florida program is proposed, that would consist of periodic reviews and updating of a program plan in solar energy, analysis of the impact of solar implementation on the existing energy distribution network and energy use patterns, analysis of the current status of solar cooling systems, and analysis of possible agricultural and industrial uses for solar energy. Considerations of testing, commercialization, and information dissemination are discussed. P.T.H.

**A79-23752** Buoyancy effects in a solar regenerator. P. Gandhidasan, V. Sriramulu, and M. C. Gupta (Indian Institute of Technology, Madras, India). *Solar Energy*, vol. 22, no. 1, 1979, p. 9-14. 12 refs.

In laminar forced solar regenerator the temperature of absorbent solution is different from that of the air passing over it and on account of low velocities used buoyancy forces are always present. This paper deals with the theoretical investigations of first order deviation of heat and mass transfer rates due to the buoyancy effect. The governing equations have been solved by using the Runge-Kutta method. Analysis shows that the ratio of solution film velocity to air stream velocity is an important parameter that governs the performance of solar regenerators. It has been found that the effect of buoyancy is more on local heat transfer than on local mass transfer. (Author)

**A79-23753** Isotropic distribution approximation in solar energy estimations. J. V. Dave (IBM Scientific Center, Palo Alto, Calif.). *Solar Energy*, vol. 22, no. 1, 1979, p. 15-19. 5 refs.

Results of numerical calculations of the direct solar energy and the diffuse sky radiation energy passing through a tilted surface are presented for five different models of the cloud-free midlatitude summer atmosphere. The results are for models resting on a perfectly absorbing ground, and for tilted surfaces with their outward normal in the sun's meridian plane. It is shown that isotropic distribution approximations for the sky radiation can lead to errors of as much as 300-400% in the estimations of the diffuse sky energy passing through a tilted surface. P.T.H.

**A79-23754** A comparison of compound parabolic and simple parabolic concentrating solar collectors. D. P. Grimmer (California, University, Los Alamos, N. Mex.). *Solar Energy*, vol. 22, no. 1, 1979, p. 21-25. 6 refs. Research sponsored by the U.S. Department of Energy.

The compound parabolic and simple parabolic solar collectors are analyzed and compared for their ability to accept nondirect radiation and for their respective reflector arc lengths. The simple parabolic concentrator (SPC) can make use of some nondirect solar radiation if the absorber tube is intentionally enlarged so as to intercept defocused radiation. A principal advantage of collecting non-direct radiation with a SPC rather than with a compound parabolic concentrator (CPC) is the reduced materials use in the construction of the reflector, but a principal disadvantage is the reduction of acceptance angle to about 1/3 that of the CPC. However, a SPC with concentration ratio less than 10 can still collect most of the circumsolar nondirect radiation. (Author)

**A79-23755** Experiments with a flat plate solar water heating system in thermosyphonic flow. A. Shitzer, D. Kalmanovitz, Y. Zvirin, and G. Grossman (Technion - Israel Institute of Technology, Haifa, Israel). *Solar Energy*, vol. 22, no. 1, 1979, p. 27-35. 18 refs. Research supported by the Messing Foundation.

A typical Israeli water heating system in thermosyphonic flow was tested. The system consisted of two flat plate collectors painted matt black connected in parallel and a 140-liter storage tank. Total surface area of the collectors, employing the parallel flow pattern, was about 3 sq cm and they were tilted about 35 deg relative to the horizon. All collector pipes and connecting tubes were made of galvanized steel. The underside collector plate, collector tubes and storage tank were equipped with thermo-couples. A specially designed flow meter was used to measure water flow rate. Results show relatively linear temperature distributions both along the collectors and in the storage tank when no water consumption was allowed. Water flow rate was found to essentially follow solar radiation and reached a maximum of about 950 cu cm/min. This value was found to be about 33 per cent smaller than the one predicted by an analytical model developed by the authors. It was also observed that shutting the system off during the afternoon hours, when losses to the environment are enhanced, might increase system efficiency. (Author)

**A79-23757** Study of solid-gas-suspensions used for direct absorption of concentrated solar radiation. M. Abdelrahman (National Council for Research, Institute of Solar Energy, Khartoum, Sudan), P. Fumeaux, and P. Suter (Lausanne, Ecole Polytechnique

Fédérale, Lausanne, Switzerland). *Solar Energy*, vol. 22, no. 1, 1979, p. 45-48. 9 refs.

Suspensions of solid particles of the appropriate diameter in gases have interesting selective absorption properties, as they absorb solar radiation, whereas the emissivity in the IR range is low. For the numerical evaluation of the important factors governing this absorption, the absorption cross section obtained by Mie Theory was substituted in the Beer-Lambert relation of different conditions. For a given concentration and optical depth, the absorption was found to be dependent on the imaginary part of the complex index of refraction of the material used. It is also dependent on the size of the particle (represented by the diameter in case of spherical particles). For solar spectrum and spherical particles, the recommended values are 0.6 for the imaginary part of the refractive index and 0.5 micron for the diameter. These values may be satisfied by spherical particles of graphite. (Author)

**A79-23758** Solar thermal electric power systems - Comparison of line-focus collectors. W. W. Shaner and W. S. Duff (Colorado State University, Fort Collins, Colo.). *Solar Energy*, vol. 22, no. 1, 1979, p. 49-61. 15 refs.

Three types of line-focusing collectors: parabolic trough, fixed slats with movable absorber and movable slats with fixed absorber, are evaluated to find those systems that are capable of producing the lowest costs of electrical energy. Minimum costs per kW-hr are found using sequential optimization techniques that consider variations in rim angle, reflectance, aperture width, length, orientation, tracking, contour error, slat width, slat curvature, tangent slat angle, slope, installation methods, materials, fabrication methods, absorptance, emittance, cover transmittance, field shape, layout, pipe sizes, insulation thickness and turbine-generator-cooling tower efficiencies and designs. This approach provides a uniform treatment of both cost and performance for a solar thermal electric power system. This uniform treatment of solar thermal electric power systems for all collector types insures valid comparisons are made. (Author)

**A79-23760** Prediction of the performance of solar heating systems utilizing annual storage. P. J. Lunde (Center for the Environment and Man, Inc., Hartford, Conn.). *Solar Energy*, vol. 22, no. 1, 1979, p. 69-75. 5 refs.

Integrated performance equations are derived for a solar heating system in which a flat plate collector heats a well-mixed storage tank and is operated piecewise continuously. The analysis takes into account situations where the storage temperature is steadily rising from a base temperature to a final temperature or steadily dropping from a starting temperature to a final temperature. Daily heat collection with or without load can be estimated with better than engineering accuracy. For systems using annual storage, monthly system performance is predicted accurately by an integrated storage equation in those months when solar supply exceeds demand, and by an integrated collector equation in the opposite case. P.T.H.

**A79-23761** Optimum collector slope for residential heating in adverse climates. M. Iqbal (British Columbia, University, Vancouver, Canada). *Solar Energy*, vol. 22, no. 1, 1979, p. 77-79. 7 refs. Research supported by the National Research Council of Canada.

Optimum collector slope for a liquid base active solar heating system employing flat-plate collectors was investigated. The optimum collector slope was studied as a function of (1) collector area, (2) yearly total heating load and (3) the ratio of space heating load to service hot water load. Collectors facing equator only were considered. Such a system was studied in four different Canadian locations, having widely different climates. Under the above conditions, optimum collector slope varied with the amount of collector area employed. The optimum collector slope was invariant with the yearly total load itself, or the space heating to hot water load ratio. Contrary to the widely held belief, for the four locations investigated, the optimum collector slope varied from latitude - 10 deg to latitude + 15 deg, depending on the fraction of load supplied by the solar system. When this fraction is in 10-20 per cent range, optimum collector slope is latitude - 10 deg and increases almost linearly to

latitude + 15 deg at 80%. Consequently, when the fraction of load by the solar system is low, a flat roof may be profitably employed. On the other hand, when the fraction by the solar system is high, a south facing (for northern hemisphere) vertical wall may be profitably employed. (Author)

**A79-23763** Solar radiation charts. R. L. Nicholls and T. N. Child (Delaware, University, Newark, Del.). *Solar Energy*, vol. 22, no. 1, 1979, p. 91-97. 10 refs.

An equation proposed by Klein (1977) for the ratio of average daily beam radiation on a tilted plane to that on a horizontal plane at the earth's surface was solved and the results are presented in the form of solar radiation influence charts for latitudes 30, 40, and 50 N for all months of the year. Also, equations proposed by Liu and Jordan (1962) for the ratio of average daily radiation on a tilted plane to that on a horizontal plane at the earth's surface are considered, and charts for easy calculation of coefficients are presented. P.T.H.

**A79-23764** Flux-redistribution in the focal region of a planar Fresnel ring mirror. M. S. A. Sastroamidjojo (Gadjah Mada University, Jogjakarta, Indonesia) and W. Lubis (North Sumatra, University, Medan, Indonesia). *Solar Energy*, vol. 22, no. 1, 1979, p. 99-102.

An arrangement is described with which it is possible to obtain three-dimensional visualization of the effect of flux redistribution at the focal area of concentrating devices with large aberrations. A large parabolic mirror furnishing a parallel beam operates in conjunction with a cotton thread grid providing a matrix of 25 x 25 data points to construct a three-dimensional model of the focal region of a planar Fresnel ring mirror. The grid makes it possible to plot isoelectric lines on a plane a given distance from the mirror. Several such plots for different distances give the three-dimensional picture of the focus. P.T.H.

**A79-23776** Modeling and simulation. Volume 9: Proceedings of the Ninth Annual Pittsburgh Conference, University of Pittsburgh, Pittsburgh, Pa., April 27, 28, 1978. Part 1 - Energy and power system modeling - Ecological and biomedical modeling. Part 2 - Socioeconomic modeling. Part 3 - Control and identification. Part 4 - Methodology and applications. Conference sponsored by the University of Pittsburgh. Edited by W. G. Vogt and M. H. Mickle. Pittsburgh, Pa., Instrument Society of America, 1978. Pt. 1, 489 p.; pt. 2, 436 p.; pt. 3, 408 p.; pt. 4, 365 p. Price of four parts, \$75; \$20.

The modeling studies presented in this volume include energy and power system modeling, ecological and biomedical modeling, socioeconomic modeling, control systems and system identification, and algorithms and general simulation techniques. Individual topics explored include multiobjective programming and regional energy, a hybrid dynamic programming/branch-and-bound approach to general planning, models for environmental transport of radionuclides in forests, Kalman filter and finite-memory filter in multilateration, a sample-data attitude control system for the Magsat spacecraft, modeling and performance evaluation of self-diagnosing systems, nonlinear two-dimensional filtering for noise discrimination, and an explicit method for system simulation with stochastic inputs. P.T.H.

**A79-23777** A fundamental model for the evolution of a two-phase geothermal reservoir with application to environmental impact analysis. R. W. Atherton, R. B. Schainker, and A. E. DeGance (Systems Control, Inc., Palo Alto, Calif.). In: Modeling and simulation. Volume 9 - Proceedings of the Ninth Annual Pittsburgh Conference, Pittsburgh, Pa., April 27, 28, 1978. Part 1. Pittsburgh, Pa., Instrument Society of America, 1978, p. 67-73. 16 refs.

The time evolution of reservoir pore pressure in a geothermal resource is important both for the proper development of the energy resource as well as the mitigation and control of land subsidence potential. We have developed a fundamental model for the evolution

of a two-phase (steam, hot-water) geothermal reservoir. The principal physical processes have been identified through the use of reservoir engineering principles. When coupled with a simplified model for reservoir compaction, the model is capable of estimating the subsidence potential of a given exploitation scheme and evaluating strategies for its mitigation. The models were successfully applied to data for the Wairakei reservoir in New Zealand. Based upon the insight derived from the model's development, field operating policies to mitigate subsidence are proposed. (Author)

**A79-23780** An economic analysis of synthetic fuels production from eastern oil shale via hydrotreating processing. C. Lin (Texas Tech University, Lubbock, Tex.) and D. G. Nichols (Research Triangle Institute, Research Triangle Park, N.C.). In: Modeling and simulation. Volume 9 - Proceedings of the Ninth Annual Pittsburgh Conference, Pittsburgh, Pa., April 27, 28, 1978. Part 1.

Pittsburgh, Pa., Instrument Society of America, 1978, p. 283-288. 15 refs.

A process analysis and cost engineering evaluation has been performed on the hydrotreating processes for the production of clean liquid and/or gaseous fuels from a typical oil shale of the eastern United States. The results include required capital investments, operating costs and the unit product price for the two conversion process flowsheets studied. (Author)

**A79-23781** System performance predictions for solar cooling using regional stochastic weather models. E. O. Bazques and I. N. Deif (Maryland, University, College Park, Md.). In: Modeling and simulation. Volume 9 - Proceedings of the Ninth Annual Pittsburgh Conference, Pittsburgh, Pa., April 27, 28, 1978. Part 1.

Pittsburgh, Pa., Instrument Society of America, 1978, p. 289-294. 6 refs. Contract No. EY-76-S-05-4976-A003.

A probabilistic approach is used to compact real climatological data collected for several regions. This stochastic weather information, which retains weather history, is then used to predict system performance of an air-cooled solar powered air-conditioning system for these diverse climatic regions of the United States. The system simulation incorporates a flat-plate solar collector, absorption cooling components, hot storage, load calculations and automatic controls. System coefficient of performance and total insolation using the stochastic approach are seen to be in good agreement with simulation runs using real weather data when compared over the total cooling season. It is concluded that even for diverse climatic regions the present scheme of reducing a large body of local data while retaining its probabilistic structure gives the designer a compact and inexpensive tool for sizing solar systems. (Author)

**A79-23808** Digital or analog modelling in the design of hydrostatic vehicular systems. J. V. Svoboda (Concordia University, Montreal, Canada). In: Modeling and simulation. Volume 9 - Proceedings of the Ninth Annual Pittsburgh Conference, Pittsburgh, Pa., April 27, 28, 1978. Part 4.

Pittsburgh, Pa., Instrument Society of America, 1978, p. 1537-1541. 6 refs. Research supported by the National Engineering Laboratory of England; National Research Council Grant No. A-4213.

This paper discusses the use of both the digital and the analog computer modelling in the design and performance evaluation of complex hydraulic systems. The design examples of two hydrostatic vehicular drives are presented. One drive is suited for small urban cars, the other was designed for urban transport buses. Both drive systems utilize hydraulic accumulator as an energy storage assisting in vehicle acceleration and permitting regenerative braking. It is shown that the 'on-line' features of analog computing systems are indispensable in the design conception stage whereas the digital systems are more appropriate for system performance evaluation due to their practically unlimited computing capacity. (Author)

**A79-23809** Optimization of a novel hydrostatic drive performance using hybrid computing technique. J. V. Svoboda, S. Sankar (Concordia University, Montreal, Canada), and W. Blach (Rolls-Royce /Canada/, Ltd., Montreal, Canada). In: Modeling and

simulation. Volume 9 - Proceedings of the Ninth Annual Pittsburgh Conference, Pittsburgh, Pa., April 27, 28, 1978. Part 4.

Pittsburgh, Pa., Instrument Society of America, 1978, p. 1543-1547. 8 refs. National Research Council Grants No. 042-271; No. 040-293.

The paper describes the performance optimization of a novel hydrostatic vehicular drive using the hybrid computing technique system consisting of a small IC-engine, a hydrostatic transmission and a hydraulic accumulator energy storage which facilitates regenerative braking and was conceived with the aid of the analog computer. Thus obtained preliminary design was repeatedly 'driven' through a short driving cycle under the control of the digital computer. The direct search optimization routine stored in the digital system monitored and evaluated the drive performance, and readjusted two drive controller parameters. The objective of the optimization was to minimize the fuel consumption without any loss of drive dynamics. The comparison of the drive performance before and after optimization is presented and discussed. (Author)

**A79-23827** Substitute natural gas from coal using high-temperature reactor heat - Project 'Prototype Plant Nuclear Process Heat' (Synthetisches Erdgas aus Kohle und Hochtemperaturreaktor-Wärme - Projekt 'Prototypanlage Nukleare Prozesswärme'). E. Arndt (Hochtemperatur-Reaktorbau GmbH, Mannheim, West Germany), R. Fischer (Gesellschaft für Hochtemperaturreaktor-Technik mbH, Bergisch-Gladbach, West Germany), W. Fröhling, I. Weisbrodt (Kernforschungsanlage Jülich GmbH, Jülich, West Germany), H. Jüntgen (Bergbau-Forschung GmbH, Essen, West Germany), and H. Teggers (Rheinische Braunkohlenwerke AG, Cologne, West Germany). *Erdöl und Kohle Erdgas Petrochemie vereinigt mit Brennstoff-Chemie*, vol. 32, Jan. 1979, p. 17-23. 7 refs. In German. Research supported by the Bundesministerium für Forschung und Technologie.

The considered project is concerned with the further development of the processes for the transformation of solid fossil fuels on the basis of a use of heat from high-temperature reactors. Designs which are suitable for the construction of a prototype plant for an operational study of these processes are also to be obtained. The development of nuclear coal gasification takes place in several steps. The first steps are related to the design of suitable gasification procedures on a laboratory-scale basis, the design and operations of medium-scale experimental equipment for the selected gasification procedures, and studies concerning the design of large-scale installations for nuclear coal gasification. Details regarding the design of large-scale installations are discussed. Attention is also given to research and development work concerning the gasification technologies and the high-temperature reactor. G.R.

**A79-23828** Gasification of coal with high-temperature reactor heat - Investigations concerning the market and the economics (Vergasung von Kohle mit Hochtemperaturreaktor-Wärme - Markt- und Wirtschaftlichkeitsuntersuchungen). H. Bialuschewski (Rheinische Braunkohlenwerke AG, Cologne, West Germany), K. H. Bode (Hochtemperatur-Reaktorbau GmbH, Mannheim, West Germany), L. Hardt (Bergbau-Forschung GmbH, Essen, West Germany), G. Joswig, H. J. Neef (Kernforschungsanlage Jülich GmbH, Jülich, West Germany), and H. W. Schmitz (Gesellschaft für Hochtemperaturreaktor-Technik mbH, Bergisch Gladbach, West Germany). *Erdöl und Kohle Erdgas Petrochemie vereinigt mit Brennstoff-Chemie*, vol. 32, Jan. 1979, p. 24-26. In German. Research supported by the Bundesministerium für Forschung und Technologie.

The combination of coal and nuclear energy represents for West Germany an approach for the substitution of imported energy carriers which are more and more in short supply. The gasification of coal to substitute natural gas (SNG), in particular, provides a product for which the existing distribution and consumption structure of the natural gas can be largely utilized without a need for major additional investments. An analysis of the thermal energy market in West Germany was conducted to obtain an estimate regarding the employment potential of SNG. Production costs of SNG are compared with prices for fuel oil and natural gas, taking into account



data for installations starting operations in 1976 and in the year 2000. It is found that the costs for SNG obtained from lignite is significantly lower than the costs for SNG obtained from other types of coal. Nuclear gasification is significantly more economical than autothermal gasification. Costs for SNG obtained in the year 2000 from lignite by means of nuclear gasification are lower than estimated costs of fuel oil and natural gas in the same year. G.R.

**A79-23829** Methane formation during the hydrogasification and the gas phase pyrolysis of defined aromatics (Methanbildung bei Wasserstoff vergasung und Gasphasenpyrolyse definierter Aromaten). W.-D. Gräber and K. J. Hüttinger (Karlsruhe, Universität, Karlsruhe, West Germany). *Erdöl und Kohle Erdgas Petrochemie vereinigt mit Brennstoff-Chemie*, vol. 32, Jan. 1979, p. 26-31. 31 refs. In German. Research supported by the Deutsche Forschungsgemeinschaft.

Advantages regarding a production of substitute natural gas from coal are related to the high calorific value of methane and the possibility to utilize existing supply and distribution installations for natural gas. The reported investigation is concerned with problems related to the methane formation process. Aromatics used in a number of experiments include benzene, naphthalene, 1-methyl naphthalene, 2-methyl naphthalene, and diphenyl methane. Reaction temperatures in the range from 600 to 1000 C were used. In the case of benzene and naphthalene noticeable methane formation was first observed at temperatures in the range from 850 to 900 C. The formation of methane in the case of 1-methyl naphthalene, 2-methyl naphthalene, and diphenyl methane begins already at temperatures in the range from 600 to 700 C. G.R.

**A79-23830** Oil shale in the U.S. - Current state of technology and research (Ölschiefer in den USA - Stand der Technik und Forschung). H.-H. Schmitz (Bundesanstalt für Geowissenschaften und Rohstoffe, Hannover, West Germany). *Erdöl und Kohle Erdgas Petrochemie vereinigt mit Brennstoff-Chemie*, vol. 32, Jan. 1979, p. 31-34. In German.

Programs have been undertaken by agencies of the U.S. Government with the objective to develop and demonstrate technologies for obtaining energy from oil shale by means of economical, operationally reliable, and environmentally acceptable approaches. Data for economically feasible methods are to be obtained until 1980. The results of the investigations, which are funded by the U.S. Government, are to be made available to private industry. A description is presented of the main research institutes which are engaged in the programs of the U.S. Government concerned with oil shale, taking into account the Laramie Research Center, the Lawrence Livermore Laboratory, the Sandia Laboratories, and the Los Alamos Scientific Laboratory. Attention is also given to the activities of private firms and the current economical situation. G.R.

**A79-23832** Hot dry rock - A new potential for energy. R. A. Pettitt (California, University, Los Alamos, N. Mex.). *Geothermal Energy*, vol. 6, Nov. 1978, p. 11-19. 16 refs.

The technology for exploiting hot dry rock (HDR) energy is discussed with attention to the development work by the Los Alamos Scientific Laboratory (LASL). The concept of a man-made geothermal reservoir where conventional hydraulic fracturing techniques are used is described, noting that after forming a circulation loop by drilling a second hole into the top of the fracture region, the heat contained in the reservoir is connected to the surface by pumping. The drilling techniques (to depths of over 9600 ft) for the holes GT-2 and EE-1 at Fenton Hill (New Mexico) are also described, with the results of the flow testing in 1978 showing that thermal contraction and pore fluid pressurization may have enlarged the accessible volume of rock considerably. Future flow tests will be aimed at further characterization of the fractured reservoir, and it is projected that in 1979 the Fenton Hill system will be expanded by drilling to 12,000 ft where temperatures of 250 C are expected. The first demonstrations of the use of geothermal energy might be possible by 1985. A.A.

**A79-23867** Solar-cell panel simulator. D. Baert (Gent, Rijksuniversiteit, Ghent, Belgium). *Electronics Letters*, vol. 15, Jan. 18, 1979, p. 53, 54.

The energy generated by solar cells can be transformed into ac power by means of inverters. In most cases these inverters cannot be tested under real conditions, since large solar-cell arrays are not yet available at reasonable prices. Therefore, a circuit that simulates a solar-cell array has been developed. (Author)

**A79-23975** Winglets give USAF KC-135 new look in life. *Aviation Engineering and Maintenance*, vol. 3, Jan. 1979, p. 24-26.

The function of the winglets, projected to be installed at the end of the KC-135 wings, and currently under testing at the Air Force Flight Development Laboratory, is described, together with a presentation of some technical aspects involving the installment. The use of the winglets is expected to improve range and fuel consumption by about 6% and enhance the overall operational capabilities of the aircraft. Tests have shown though that the winglets have a torquing effect on the aircraft wing, requiring thus modifications on the wing. The final series of flight tests will take place in the early 1980's. A.A.

**A79-24037** Electron cyclotron heating in high density toroidal plasmas. T. Maekawa, S. Tanaka, Y. Hamada, and Y. Terumichi (Kyoto University, Kyoto, Japan). *Physics Letters*, vol. 69A, Jan. 22, 1979, p. 414-416. 6 refs.

A theoretical analysis is presented of wave trajectories of ordinary and extraordinary modes injected obliquely into the magnetic fields of high-density toroidal plasmas. It is found that both the O mode injected from outside the torus and the X mode injected from inside are converted into Bernstein waves which propagate toward the center of the plasma column and are cyclotron-damped, resulting in local electron heating. The effect of the rotational transform on the Bernstein wave is pronounced. B.J.

**A79-24040** Weak points of our prediction models for raw materials strategy (Schwachstellen unserer rohstoffstrategischen Prognosemodelle). K. H. Schmid (Siemens AG, Munich, West Germany). *Metall*, vol. 33, Feb. 1979, p. 193-196. 22 refs. In German.

It is argued that the recovery of production process waste materials and the recovery of scrap material will not, under realistic assumptions, contribute a significant amount to the covering of future needs in various industrial materials. Possibilities for estimating scrap metal potential are pointed out. Various optimistic estimates of energy savings by secondary material recovery are refuted. P.T.H.

**A79-24045** Solar energy storage as hydrogen and bromine from hydrogen bromide. E. A. Fletcher (Minnesota, University, Minneapolis, Minn.). *Energy (UK)*, vol. 4, Feb. 1979, p. 61-66. 14 refs.

The use of hydrogen bromide as the working fluid for a one-step thermochemical solar energy storage device is considered. When dissociation of Br<sub>2</sub> into Br at moderately high temperatures is taken into account, the system becomes one in which high-temperature separation of hydrogen from bromine in one step appears attractive. (Author)

**A79-24046** Geothermal energy in Imperial County, California - Environmental, socio-economic, demographic, and public opinion research conclusions and policy recommendations. M. J. Pasqualetti (Arizona State University, Tempe, Ariz.), J. B. Pick, and E. W. Butler (California, University, La Jolla, Calif.). *Energy (UK)*, vol. 4, Feb. 1979, p. 67-80. 40 refs. NSF Grant No. AER-75-08693.

**A79-24047** Industrial cogeneration - Problems and promise. L. Icerman and D. M. Staples (Washington University, St. Louis, Mo.). *Energy (UK)*, vol. 4, Feb. 1979, p. 101-117. 46 refs. Research sponsored by the Missouri Department of Natural Resources.



Considerable potential for industrial cogeneration of electricity and process heat is currently available in the U.S. A number of prime mover technologies suitable for application in cogeneration facilities are already technically proven in other conventional systems. Industries with particularly attractive opportunities include paper and pulp, chemical, petroleum refining, iron and steel, and cement manufacturers. The apparent technical potential is limited significantly by economic, environmental, and regulatory factors, as well as by the need for new dimensions in industry and utility cooperation. Although substantial societal benefits in the form of energy conservation are available from a strong commitment to industrial cogeneration systems, many obstacles to systems deployment remain, which will not be readily overcome without the adoption of policy incentives. (Author)

**A79-24048** Cost-effectiveness of the vortex-augmented wind turbine. O. Igra (Negev, University, Beersheba, Israel). *Energy* (UK), vol. 4, Feb. 1979, p. 119-130. 20 refs.

Cost estimates for the conventional, horizontal-axis, wind turbine and for the vortex-augmented wind turbine are presented. For the latter, the vortex is generated by an appropriate delta wing. It is shown that the vortex-augmented wind turbine competes well with the conventional type. Its economical advantage increases with increasing output power. (Author)

**A79-24137** Failure analysis in coal conversion systems. R. T. King (Oak Ridge National Laboratory, Oak Ridge, Tenn.). In: *Materials synergisms; Proceedings of the Tenth National Technical Conference, Kiamesha Lake, N.Y., October 17-19, 1978.*

Azusa, Calif., Society for the Advancement of Material and Process Engineering, 1978, p. 792-801. 5 refs. Contract No. W-7405-eng-26.

The paper is concerned with causes of material failures in pilot plants for coal conversion to alternate fuels: Examination of a coal liquefaction plant dissolver tank and related fittings as well as the analysis of atmospheric fluidized bed combustor air distributor plates are described. The range of tests required to identify material failures in plant components is considered. M.L.

**A79-24138 \*** Encapsulant materials for \$2/watt terrestrial photovoltaic arrays. H. Maxwell (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In: *Materials synergisms; Proceedings of the Tenth National Technical Conference, Kiamesha Lake, N.Y., October 17-19, 1978.*

Azusa, Calif., Society for the Advancement of Material and Process Engineering, 1978, p. 812-823. 9 refs.

Materials properties, cost data, and strawman designs are presented relative to materials for \$2/watt terrestrial photovoltaic arrays to meet LSA Project cost goals for 1982. It is shown that encapsulation materials can be categorized in six basic elements: top covers, superstrates, pottants, adhesives, substrates, and bottom covers. The roles of the six basic encapsulant material elements in the encapsulant system are discussed and candidate materials presented. (Author)

**A79-24151** Risk with energy from conventional and non-conventional sources. H. Inhaber. *Science*, vol. 203, Feb. 23, 1979, p. 718-723. 18 refs.

Risk to human health was compared for five conventional and six nonconventional energy systems, and it is concluded that, in terms of the risk per unit energy, the risk from nonconventional sources can be as high as, or even higher than, that of conventional sources. The conventional sources considered are coal, oil, nuclear, natural gas, and hydroelectricity, while the nonconventional sources are wind, methanol, solar space heating, solar thermal, solar photovoltaic, and ocean thermal. The risk from nonconventional sources is attributed to the large amount of material and labor required for utilization of the source as well as to backup and storage requirements. M.L.

**A79-24239** The geothermal power station at Ahuachapan, El Salvador. R. DiPippo. *Geothermal Energy*, vol. 6, Oct. 1978, p. 11-22. 7 refs. Contract No. EY-76-5-02-4051-A001.

The geothermal power station at Ahuachapan (El Salvador) is described, together with information on the reservoir characteristics and well programs. Consideration is given to the geofluid collection and transmission system consisting of a 14 in. control valve, through which the two-phase geofluid passes, a cyclone separator with a capacity of 350 Mg/h, a vertical hot water collecting tank, two vertical silencers for flashing the liquid to atmospheric conditions, and four reinjection wells. The energy conversion system is particularly noted, indicating that it consists of an auxiliary turbo-generator unit, used for station start-up from cold conditions, and two main power units, each employing a double-flow turbine with impulse-reaction blading, and developing 30 MW. It is concluded that the experience at Ahuachapan has shown that a liquid-dominated resource of moderate salinity (18,400 PPM) and relatively high temperature (230 C bottomhole) can provide electricity in an economical and reliable manner. A.A.

**A79-24240** Soil cooling for geothermal electric power plants in the Western United States - The Raft River experiment. N. E. Stanley, D. L. Slegel, and W. D. Gertsch (EG & G Idaho, Inc., Idaho National Engineering Laboratory, Idaho Falls, Idaho). *Geothermal Energy*, vol. 6, Oct. 1978, p. 23-25. 7 refs.

**A79-24275** Tropospheric conduits. C. E. Kaempfen (Kaempfen Industries, Inc., Orange, Calif.). *Energy Communications*, vol. 4, no. 6, 1978, p. 499-507.

Structure, use, cost, and performance of tropospheric conduits are described. A tropospheric conduit is essentially a vertical tube which connects lower portions of the troposphere with its upper portions having different temperatures and pressures, with the typical structure consisting of an aerostatically supported conduit measuring 100 m in diam and 2000 m in height, and large circular rooms at the lower portion. Electrical energy is generated by an air tubing system, and if a typical system is located where a lapse rate of 23 C is possible to attain, it will produce approximately 100 MW of electrical energy. The system could also produce about 80 million liters of fresh water each day if it were located where inlet air at ground level contains 5 g of water vapor per cu m of air. Further, it can remove as much as 13 million cu m of polluted air every minute. Tropospheric conduit systems could be constructed in less than five years for a total cost of about \$100,000,000 each, taking advantage of the progress done with plastic materials. A.A.

**A79-24309** Modeling, simulation, testing, and measurements for solar energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978. Meeting sponsored by the American Society of Mechanical Engineers. Edited by J. M. Nash, J. T. Smok (IBM Corp., Federal Systems Div., Gaithersburg, Md.), W. C. Thomas (Virginia Polytechnic Institute and State University, Blacksburg, Va.), and P. E. Jenkins (Texas A & M University, College Station, Tex.). New York, American Society of Mechanical Engineers, 1978. 105 p. Members, \$9.00; nonmembers, \$18.

Methods of modeling and simulating solar energy systems are presented and applied to various types of systems. Topics studied include a modular approach to solar system modeling with generalized programs for working fluid properties, study of effects of low solar input and storage amount on thermosyphon hot water system performance, optimization of passive solar characteristics of buildings, a model of a liquid solar energy storage tank, and a study of the effects of test fluid, flow rate, and flow regime on solar collector thermal performance. P.T.H.

**A79-24310 #** Solar system modeling using a modular approach with generalized programs for working fluid properties. T. C. Scott (Virginia, University, Charlottesville, Va.). In: *Modeling, simulation, testing, and measurements for solar energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December*

10-15, 1978. New York, American Society of Mechanical Engineers, 1978, p. 1-13. 31 refs.

A technique of efficiently modeling solar energy systems for computer simulation is described. The technique is based on a modular approach and allows one to rapidly create simple models having a wide range of flexibility. Such models are extremely useful during the initial feasibility study phase when a large number of possible system configurations must be examined. The structure of a library of computer programs for the evaluation of the thermo-physical properties of fluids is also described. Such a library is necessary as a supporting tool for the analysis of many thermo-fluids problems and greatly simplifies the task of modeling solar energy systems. The value of the modeling method and the properties library is illustrated by applying them to the initial study of a Rankine cycle assisted vapor compression refrigeration unit. The purpose is to show how one can gain a large amount of information from simple models through the use of this technique. (Author)

**A79-24311 #** The effects of internal latent energy storage on the operational dynamics of a solar-powered absorption cycle. A. W. Harris (General Electric Co., Schenectady, N.Y.) and C. N. Shen (Rensselaer Polytechnic Institute, Troy, N.Y.). In: Modeling, simulation, testing, and measurements for solar energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978. New York, American Society of Mechanical Engineers, 1978, p. 15-24. 12 refs.

A system diagram and performance equations are presented for a solar-powered absorption cycle heat pump system utilizing latent energy storages internal to the absorption cycle itself. A water-lithium bromide absorption cycle heat pump directly coupled to a flat plate solar collector is considered. Generalized weather functions are used to represent insolation and heating/cooling load inputs to the model. All collected solar energy is utilized in generating stored refrigerant by means of control of refrigerant-absorbent mixture flow to the generator. An operational algorithm to maximize the production of stored refrigerant as a function of solar energy intensity is shown. The relative operational independence of the collector/generator/condenser from the load demand/evaporator/absorber is emphasized. Comparisons are made between the diurnal operation of the solar-powered internal latent energy storage absorption cycle heat pump system and one having an external sensible heat storage between collector and absorption cycle generator. These comparisons show that auxiliary energy requirements are greatly reduced by introducing the internal latent energy storages. (Author)

**A79-24312 #** Effects of low solar input and amount of storage on thermosyphon hot water system performance. D. A. Dougherty (General Electric Co., Nuclear Energy Engineering Div., San Jose, Calif.) and J. W. Baughn (California, University, Davis, Calif.). In: Modeling, simulation, testing, and measurements for solar energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978. New York, American Society of Mechanical Engineers, 1978, p. 25-31. 9 refs.

The response of a flat-plate solar water heating system operating with natural circulation (thermosyphon) to marginal solar radiation and the effect of the amount of storage per unit collector area have been investigated using an analytical model. The model has been verified previously by comparison with measurements taken on an experimental system. Increasing the amount of storage was found to increase the instantaneous and accumulated efficiencies of the system, but at a loss in average storage temperature. On days of marginal solar input, the thermosyphon system was found to perform as well as pumped systems, even as well as pumped systems having thermostatic controls. Pumped systems may increase or decrease the amount of thermal stratification in the storage tank, but do not change the system efficiencies significantly, except with very low flow rates, which may cause appreciable efficiency losses. (Author)

**A79-24313 #** A computer simulation model for determining preferred solar heating and cooling systems. R. L. Merriam, D.

Nathanson, and P. M. O'Farrell (Arthur D. Little, Inc., Cambridge, Mass.). In: Modeling, simulation, testing, and measurements for solar energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978. New York, American Society of Mechanical Engineers, 1978, p. 33-42. Research supported by the Electric Power Research Institute.

A 'preferred' solar heating system is understood in this paper to mean one that minimizes the total cost of meeting the energy needs of an application, where the supply cost to the electric utility, and not the utility rate, is taken into account. A computer model is developed for determining a preferred solar heating system. The model simulates the transient thermal behavior of the building and the heating, ventilating, and air conditioning (HVAC) equipment. From the input data, energy balance coupling equations are automatically constructed within the program and are solved at each time step. User-defined control functions determine the interrelationships among system elements and when the various components are activated. Actual weather data are used, and the dynamic behavior of the HVAC system is simulated in response to the hourly building heating and cooling loads. The outputs give descriptions of the technical performance of the house and HVAC system, and provide a breakdown showing various components of the utility's costs. P.T.H.

**A79-24314 #** A liquid solar energy storage tank model. I - Formulation of a mathematical model. S. T. Wu and S. M. Han (Alabama, University, Huntsville, Ala.). In: Modeling, simulation, testing, and measurements for solar energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978. New York, American Society of Mechanical Engineers, 1978, p. 53-60. 12 refs. Contract No. EG-77-S-02-4479.

A one-dimensional model of the liquid energy storage tank, which is compatible with TRNSYS, was formulated as an initial-boundary value problem. Resulting governing equations were then numerically solved by the Crank-Nicolson finite difference method. The numerical results were compared with existing experimental data and other available models to show that the present model produced better agreements with the experimental results. Advantages of the present model are: (1) simplicity in mathematical expression of the model, (2) explicit appearance of all important parameters associated with thermal stratification, (3) capability of representing realistic thermocline, and (4) the effects of an internal heat exchanger inside the storage tank can be easily incorporated. (Author)

**A79-24315 #** Solar energy for industrial process steam. S. B. Youngblood, D. M. Bell, and D. F. Brink (Acurex Corp., Mountain View, Calif.). In: Modeling, simulation, testing, and measurements for solar energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978. New York, American Society of Mechanical Engineers, 1978, p. 61-71.

The analysis and design of a solar energy system that will supply 446 K steam to a gauze-bleaching process is summarized. As part of a program for the Department of Energy, the system will demonstrate the technical and economic feasibility of generating low-pressure steam (saturated, 373 to 450 K) with solar energy for industrial processes. The resulting design consists of 1,070 sq m of line-focusing parabolic trough concentrators that will supply approximately 60 percent of the annual process energy demand. (Author)

**A79-24316 #** The cryogenic heat transfer tunnel - A new tool for convective research. A. M. Clausing, C. L. Clark, and M. H. Mueller (Illinois, University, Urbana, Ill.). In: Modeling, simulation, testing, and measurements for solar energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978. New York, American Society of Mechanical Engineers, 1978, p. 73-78. Research supported by the U.S. Department of Energy.

A novel heat transfer technique, the use of cryogenic temperatures for convective modeling, is used in this study in order to simultaneously obtain large Grashof and Reynolds numbers on a

vertical cylinder. The research is motivated by the need to predict combined convective losses from large, high-temperature objects such as solar 'power tower' receivers where the magnitudes of both the Grashof and Reynolds numbers are large. The cryogenic heat transfer tunnel provides an economical method of obtaining these large Grashof and Reynolds numbers with an appropriate and nearly constant Prandtl number; thus it is an excellent tool for study of convective heat transfer. Low-temperature modeling, a cryogenic testing facility, and a transient measurement technique are discussed.

(Author)

**A79-24317 # Effects of test fluid, flow rate, and flow regime on solar collector thermal performance measurements.** W. C. Thomas (Virginia Polytechnic Institute and State University, Blacksburg, Va.). In: Modeling, simulation, testing, and measurements for solar energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978. New York, American Society of Mechanical Engineers, 1978, p. 85-89. 8 refs.

The effects of test fluid parameters on measured collector efficiency were investigated. An analytical thermal performance model was validated by experimental results and then used to carry out parametric studies. Test fluid composition, flow rate, and flow regime were shown to have a significant effect on collector efficiency. Certain combinations of fluid composition and flow rate result in laminar-to-turbulent transition. The effects on efficiency attributable to the test fluid parameters were compared with effects expected to result from variations in the test environment. It was shown that wind and the scattered fraction of radiation can have strong effects on measured efficiency.

P.T.H.

**A79-24321 Solar energy and heat insulation (Sonnenenergie und Wärmedämmung).** H. Völker. *Sonnenenergie*, vol. 3, Nov.-Dec. 1978, p. 7, 8. In German.

It is pointed out that for optimal residential solar energy systems it will not be necessary to seek new ways of heat insulation but merely to increase the thickness of conventional insulation. Recommendations on the dimensioning of insulation consisting of mineral fibers or polystyrol materials for a typical house are given. Insulation requirements of the collector and storage units are also discussed.

P.T.H.

**A79-24322 Solar storage unit with built-in oil-gas boiler (Solarspeicher mit eingebautem Öl-Gas-Kessel).** O. Schuster. *Sonnenenergie*, vol. 3, Nov.-Dec. 1978, p. 11-13. In German.

The paper describes a hybrid boiler-solar-storage combination with integrated control of the solar-boiler heating cycle. Heat loss from the boiler is absorbed by a two-zone storage unit that nearly surrounds the boiler. During the summer, the boiler is used only when the total solar radiation is insufficient to provide the required amount of hot water. Data from thirty days of summer operation of the system are presented.

P.T.H.

**A79-24323 Stormy development of wind energy (Stürmische Entwicklung der Windenergie).** A. Jarass and L. Jarass. *Sonnenenergie*, vol. 3, Nov.-Dec. 1978, p. 14-17. 10 refs. In German. Bundesministerium für Forschung und Technologie Contract No. ET-4085-A.

The meteorological and topographical considerations for wind energy are briefly reviewed, and the potential contribution of wind energy to the energy picture in the Federal Republic of Germany is assessed. On the northern German coast the average wind speed exceeds what has been calculated as the minimum required for economically viable wind power production. There are still insufficient measurements for inland regions at the required hub heights. Several problems with regard to large-scale installations are not yet solved: (1) the need for nonfatiguing material for the rotors, (2) complex vibration behavior of the rotor-nacelle-tower system, and (3) speed-switching systems with reliable stormproofing. Surprisingly, the relation between annual energy production and annual average wind speed is roughly linear for the Growian installation, despite

the fact that kinetic energy of wind increases with the third power of wind speed. Calculations show that 1500 Growian devices would cover about 31% of the northern German electricity needs for 1977.

P.T.H.

**A79-24450 Space will be the next big construction site.** G. Bylinsky. *Fortune*, vol. 99, Feb. 26, 1979, p. 62-65, 68.

Further space constructions planned by NASA are described with particular attention to batteries of antennas, called antenna farms, and solar-power satellites. An antenna farm will consist of a metal skeleton about 700 ft long, housing as many as thirty large dish antennae, accommodating up to five nationwide television channels, and serving almost 45,000 private channels handling calls from millions of pocket telephones. The projected solar-power satellites will be capable of feeding ten megawatts of electricity into its own antenna where it will be transformed into microwaves and beamed back to earth. The construction materials will be ferried by the Shuttle.

A.A.

**A79-24486 Design of a heat pipe with separate channels for vapor and liquid.** Iu. E. Dolgirev, Iu. F. Gerasimov, Iu. F. Maidanik, and V. M. Kiseev (Ural'skii Politekhnikheskii Institut, Sverdlovsk, USSR). (*Inzhenerno-Fizicheskii Zhurnal*, vol. 34, June 1978, p. 988-993.) *Journal of Engineering Physics*, vol. 34, no. 6, Dec. 1978, p. 661-665. Translation.

The heat transfer capacity and operating conditions of an antigravity heat pipe, with separate ducts for vapor and liquid, operating in evaporation regime, are calculated. The initial data for the calculation are the height of the heat pipe, geometric dimensions, characteristics of the capillary-porous structure of the pipe, and the temperature of the vapor and condensate arriving at the feed. The temperature drop at the barrier wall of the wick is determined and the condition for nonboiling of the liquid in the equalizing gap is verified. The dependence of heat pipe operation on temperature drop at the barrier wall of the wick,  $dP/dT$  of the heat carrier at a given temperature, and hydraulic resistance of the outer circuit is determined. Computer calculations for a specific heat pipe were performed, and agreement with experimental data was good.

P.T.H.

**A79-24507 # Storage peak gas-turbine power plant (Akkumulirovushchaia pikovaia gazoturbinnaiia ustanovka).** B. Tsinkotski (Budapesti Muszaki Egyetem, Budapest, Hungary). *Periodica Polytechnica, Mechanical Engineering*, vol. 22, no. 2, 1978, p. 95-113. 5 refs.

A storage gas-turbine power plant using a two-cylinder compressor with intermediate cooling is studied. On the basis of measured characteristics of a 25 MW compressor, computer calculations of the parameters of the loading process of a constant capacity storage unit (0.5-3 million cu m) were carried out. The required compressor power as a function of time with and without final cooling was computed. Parameters of maximal loading and discharging of the storage unit were calculated, and it was found that for complete loading of a fully unloaded storage unit, a capacity of 1-1.5 million cu m is required, depending on the final cooling.

P.T.H.

**A79-24508 # A digital control system for superconducting magnet.** M. Hirano, Y. Murakami, E. Ito, and M. Nishimura (Osaka University, Osaka, Japan). *Osaka University, Technology Reports*, vol. 28, Oct. 1978, p. 401-409. 5 refs.

An inductor-converter unit which consists of a Graetz-type six-pulse converter and a solenoid superconducting magnet has been developed. A microcomputer-based controller and its input/output interfaces have also been constructed for the control system. The closed-loop control is performed through the following operations: detection of the circuit current, comparison with the reference input for generating the error signal, determination of the firing angle by PID compensation and the arc cosine correction, and generation of trigger pulses. These operations are performed by the program instructions of the microcomputer. The pattern of reference input and PID constants is given through the keyboard of the teletypewriter. These system organizations and the open-loop and close-loop system performances are described.

(Author)

**A79-24539 #** On the dynamics of wave-power devices. B. M. Count (Central Electricity Generating Board, Marchwood, Hants., England). *Royal Society (London), Proceedings, Series A - Mathematical and Physical Sciences*, vol. 363, no. 1715, Nov. 27, 1978, p. 559-579. 17 refs.

The theory of ship dynamics is used to study the performance of a class of wave-power devices. Results are presented for two different devices and a comparison is made between them. The Salter duck and a two-pontoon system, semielliptical in cross section and hinged at its center, constrained to move only in the mode in which energy is absorbed, appear to be equivalent. Both structures are designed so that when forced to move in their absorbing mode they generate waves in one preferred direction, the pontoon design relying on the use of a shallow horizontal breakwater in the rear of the moving structure, while the Salter device uses a shorter, deeper structure which looks almost cylindrical.

B.J.

**A79-24611** Electric vehicle progress in the U.S. - Where to. G. Greenberg. *Energy*, vol. 4, Winter 1979, p. 7-9, 13.

The state of the electric vehicle industry in the United States is reviewed, focusing on government efforts to promote development. A demonstration program using up to 7500 vehicles by 1984 and intended to identify specific markets where electric and hybrid vehicles can be introduced and accepted is detailed, and government contracts and incentive loans for electric vehicles noted. A government assessment of electric and hybrid vehicle technology is being conducted based on operational data derived from demonstration project vehicles, as well as commercially available vehicles, in order to improve state-of-the-art components. Ongoing research on electric batteries, mechanical energy storage systems and propulsion systems by government and private industries is outlined, noting however that small manufacturers are still the major force in the industry.

A.L.W.

**A79-24612** Wind energy - The long road to commercialization. L. A. Braunstein. *Energy*, vol. 4, Winter 1979, p. 10, 11, 20.

Various programs of wind energy research are examined and their potential for commercial development is evaluated. The Department of Energy (DOE) is testing a variety of small wind-powered machines at its Colorado facility and small-to-medium sized machines in farm applications at other sites. Large-scale wind turbines are also being developed as electric power generators. Most of DOE's large turbines are horizontal axis machines, however the vertical axis design, which accepts wind from any direction, is also being investigated. Although studies have shown an economy of scale for large wind machines, small systems are considered economical in remote regions. At present, wind-derived electricity costs (15 cents per kwhr for small machines and from 10 to 20 cents per kwhr for large turbines) are not competitive with utility-produced power costs (4 to 6 cents per kwhr) and efforts are being made to reduce costs according to DOE goals. Wind energy though is approaching commercialization and appears capable of reaching cost goals sooner than photovoltaic or solar thermal power systems.

A.L.W.

**A79-24620** Continental geotherms during the Archaean. P. C. England (Cambridge University, Cambridge, England). *Nature*, vol. 277, Feb. 15, 1979, p. 556-558. 13 refs.

It is found that P-T data from high grade Archaean terrains represent temperatures reached during the exhumation of the rocks from an overthick crust and are probably not lower than equilibrium profiles for this thickened crust. At present the best upper limit which may be placed on the heat flow from the Archaean mantle from these data is 2-3 times present-day subcontinental values, and in this respect the P-T data offer no improvement in constraints of Archaean geothermal regimes over those from general observations of continental integrity in the Archaean. It would be possible to lower the upper bound on Archaean continental geothermal gradients if reliable information were obtained on the distribution of heat-producing elements in the Archaean crust and on the P-T-time paths followed during the exhumation of high grade Archaean rocks. G.R.

**A79-24621** Use of organic fluids in solar turbines (L'emploi des fluides organiques dans les turbines solaires). A. Verneau (Société Bertin et Cie., Paris, France). *Entropie*, vol. 14, no. 82, 1978, p. 9-18. In French.

The paper discusses theory and experiments on the use of a Rankine cycle engine with organic fluid vapor, where the temperature of the heat source is in the moderate range 150-300 C, in solar electric power plants. The effect of different fluid parameters on the turbine design is studied. Work on a prototype 350 kW system based on FC75 fluid, axial single-stage turbine with rotation speed of 3000 rev/min with total injection, feed temperature of 235 C, pressure ratio of 133, and 75 percent efficiency, is described.

P.T.H.

**A79-24622** Medium-power /100-1000 kWe/ solar power plants using distributed collectors (Les centrales solaires de moyenne puissance à collecteurs distribués 100 à 1 000 kWe). J.-L. Boy-Marcotte (Société Bertin et Cie., Paris, France). *Entropie*, vol. 14, no. 82, 1978, p. 19-25. In French.

Work on a prototype medium power solar power plant involved design, construction, and testing of solar collectors, storage, and organic fluid turbo-alternator. An optimization plan was carried out to reduce the cost of the electric power produced. The ratio of delivered electric power to incident solar energy was between 9 and 10 percent. The result of the study is a medium temperature heat generator that may find application in the production of industrial heat in the range 100-250 C.

P.T.H.

**A79-24623** Current status and prospects for low-temperature solar energy (Réalisations et perspectives de l'énergie solaire à basse température). B. Devin (Commissariat à l'Energie Atomique, Centre d'Etudes Nucléaires de Saclay, Gif-sur-Yvette, Essonne, France). *Entropie*, vol. 14, no. 82, 1978, p. 26-31. In French.

The cost of low-temperature solar collection is examined, and possible ways in which the future costs will be reduced are mentioned. The storage problem for countries with a climate such as that of France is discussed. The growth of thermomechanical systems fed by solar energy is briefly outlined. The possibility of exporting low-temperature solar energy to developing countries is pointed out.

P.T.H.

**A79-24813** Stability criteria for current-driven drift wave eigenmodes. D. W. Ross and S. M. Mahajan (Texas, University, Austin, Tex.). *Physics of Fluids*, vol. 22, Feb. 1979, p. 294-300. 18 refs. Contract No. EY-77-C-05-4478.

Eigenmodes of current-driven collisionless electrostatic drift waves in a sheared magnetic field are reexamined in the light of the recent discovery that their non-current-driven counterparts are stable. Conditions for instability are determined from numerical finite difference and variational solutions of the slab model differential equation. It is found that three stringent conditions are required for instability: (1) very weak shear, (2) low ion temperature, and (3) very large parallel drift velocity. For  $L(n)/L(s) = 0.02$  and  $T(i)/T(e) = 0$ , the instability threshold is  $u(d)/c(s) = 0.85$ , where  $L(n)$  and  $L(s)$  are the density and shear scale lengths, respectively,  $u(d)$  is the drift velocity, and  $c(s)$  is the sound speed. For larger shear and finite ion temperature the critical drift velocity is even larger. It is concluded that drift wave fluctuations in tokamaks cannot be described in terms of these eigenmodes.

(Author)

**A79-24814** Parametric decay of lower hybrid waves in a plasma - Effect of ion nonlinearity. V. K. Tripathi, C. S. Liu, and C. Grebogi (Maryland, University, College Park, Md.). *Physics of Fluids*, vol. 22, Feb. 1979, p. 301-309. 12 refs. Research supported by the University of Maryland, U.S. Department of Energy, U.S. Navy, Conselho Nacional de Desenvolvimento Científico e Tecnológico, and NSF.

By using a simple scheme for calculating ion nonlinear effects in guiding center coordinates, the contribution of ions in the coupling coefficients is calculated for various channels of parametric decay, quasi-mode decay, oscillating two-stream instability, and modula-

tional instability, of a lower hybrid pump with finite wave vector in a homogeneous plasma. It is found that decay into quasi-modes and the oscillating two-stream instability are the most likely candidates in all regimes of density relevant to tokamaks. The nonlinear ion cyclotron damping has a growth rate comparable to nonlinear electron Landau damping, so efficient ion heating is expected. Parametric decay into ion cyclotron and Bernstein waves have comparable growth rates to quasi-modes for low values of the  $E \times B$  electron drift velocity to ion sound speed ratio. Decay into two lower hybrid waves is important in the low density region and only for nonuniform pump. Modulational instability is insignificant in the whole range of parameters. The contribution of ions is important only for the decay into ion Bernstein waves. P.T.H.

**A79-24817** Microstability of a focused ion beam propagating through a z-pinch plasma. P. F. Ottinger, D. Mosher (U.S. Navy, Naval Research Laboratory, Washington, D.C.), and S. A. Goldstein (Science Applications, Inc., McLean, Va.). *Physics of Fluids*, vol. 22, Feb. 1979, p. 332-337. 10 refs. Research supported by the U.S. Department of Energy.

A beam-plasma system consisting of a focused light ion beam propagating through a z-pinch plasma is analyzed for microinstabilities. Two instabilities are discussed, one driven by the relative streaming between beam ions and electrons and the other driven by streaming between plasma ions and electrons. Conditions for stability of both modes are derived and are used to demonstrate that ion beams appropriate for use in a pellet fusion device can be propagated to the pellet through a z-pinch plasma without disruptive microturbulence. (Author)

**A79-24827** Engine technology for production turbofan engines. B. Walsh. *Aviation Engineering and Maintenance*, vol. 3, Feb. 1979, p. 28-31.

Technologies sponsored by NASA for the improvement of the JT8D and JT9D turbofan engines used on commercial transports are discussed. The four concepts in progress for the JT8D engine are (1) the development of an abradable trenched HP compressor blade resulting in a tighter blade clearance and an increase in the compressor's efficiency, (2) the modification of the turbine blade, (3) the replacement of the single pass blade with a two-pass root discharge blade with lower cooling air flow, and (4) the introduction of an advanced composite, the Kevlar PMR. The concepts in progress for the JT9D are: the design of a 3.8 aspect ratio fan blade for modifying aerodynamic airfoil, modification of first and second stage outer air seal supports, and coating of vane platforms and seal with Zirconia/NiCoCrAlY spray. The new technologies are expected to provide fuel savings ranging from 0.8% to 1.5%. A.A.

**A79-24852** Electrons of high perpendicular energy in the low-density regime of tokamaks. M. Bornatici (Pavia, Università, Pavia, Italy), F. Engelmann (EURATOM and Stichting voor Fundamenteel Onderzoek der Materie, Instituut voor Plasmafysica, Jutphaas, Netherlands), C. S. Liu, Y. Mok, and K. Papadopoulos (Maryland, University, College Park, Md.). In: Plasma transport, heating and MHD theory; Proceedings of the Workshop, Varenna, Italy, September 12-16, 1977. Oxford, Pergamon Press, Ltd., 1978, p. 7-28; Discussion, p. 29-31. 23 refs. Research supported by the Nederlandse Organisatie voor Wetenschappelijk Onderzoek and EURATOM.

**A79-24854** Non-thermal emission at the plasma frequency. G. Ramponi, P. Brossier, and I. Fidone (EURATOM and CNR, Laboratorio di Fisica del Plasma, Milan, Italy). In: Plasma transport, heating and MHD theory; Proceedings of the Workshop, Varenna, Italy, September 12-16, 1977. Oxford, Pergamon Press, Ltd., 1978, p. 41-47; Discussion, p. 48.

Spectra obtained on the TFR under experimental conditions where the emission at the harmonics of the central electron cyclotron frequency is close to thermal exhibit an anomalous peak at

a frequency below the central electron cyclotron frequency with an amplitude that can be as high as 40 times the blackbody level. This emission always occurs at the central electron plasma frequency. The peak intensity is maximum early in the discharge and decays with a time constant of the order of 100 msec. There is some correlation between the power emitted at the electron plasma frequency and the instantaneous runaway creation rate. These observations suggest the presence of suprathermal electrons during the active phase of emission of radiation. On the assumption that the distorted distribution function of the electrons in the direction of the confining magnetic field is unstable against electrostatic waves, a model for the process is developed, from which an estimate of the order of magnitude of the radiated energy flux is obtained. P.T.H.

**A79-24855** Asymptotic theory of dissipative trapped electron mode overlapping many rational surfaces. A. Rogister and G. Hasselberg (EURATOM and Kernforschungsanlage Jülich GmbH, Institut für Plasma physik, Jülich, West Germany). In: Plasma transport, heating and MHD theory; Proceedings of the Workshop, Varenna, Italy, September 12-16, 1977. Oxford, Pergamon Press, Ltd., 1978, p. 49-59; Discussion, p. 59, 60. 6 refs.

The two-dimensional eigenvalue equation describing the dissipative trapped electron mode is solved exactly in the limit of the mode overlapping many rational surfaces by use of the Pogutse model for the magnetic field and the pitch angle collision operator. It is shown that the trapped electron contribution to the growth rate is decreased, with respect to the standard theory, by a factor of a certain order. Conditions under which marginal stability is obtained are derived. P.T.H.

**A79-24858** Theory of anomalous transport due to electrostatic fluctuations. T. E. Stringer (EURATOM and U.K. Atomic Energy Authority, Culham Laboratory, Abingdon, Oxon, England). In: Plasma transport, heating and MHD theory; Proceedings of the Workshop, Varenna, Italy, September 12-16, 1977.

Oxford, Pergamon Press, Ltd., 1978, p. 103-121; Discussion, p. 122-128. 24 refs.

Theories of cross-field transport due to low-frequency electrostatic instabilities of the drift wave type are reviewed. First, attention is given to quasilinear theory, which predicts particle and energy transport proportional to the wave amplitude squared. An estimate of the saturation level leads to a well-known estimate for the particle diffusion coefficient. The transport mechanism described by the quasilinear analysis is examined critically, and its relevance to anomalous transport in a confined plasma is discussed. Numerical simulation of the transport process is discussed by following particle motions in the self-consistent fields of one or more unstable modes. Comparison between theory and tokamak experiments is made, and it is found that measured anomalous transport is comparable to the upper limit on quasilinear transport. Measured fluctuations agree in most respects with the linear drift wave theory. P.T.H.

**A79-24859** Quasi-linear theory of heat flow and diffusion in a tokamak. N. A. Krall and J. B. McBride (Science Applications, Inc., Laboratory for Applied Plasma Studies, La Jolla, Calif.). In: Plasma transport, heating and MHD theory; Proceedings of the Workshop, Varenna, Italy, September 12-16, 1977.

Oxford, Pergamon Press, Ltd., 1978, p. 129-142; Discussion, p. 143-147. 10 refs.

A formulation of transport theory, including cross-field thermal conductivity, is presented and applied to transport in tokamaks due to trapped-particle instabilities, in the quasi-linear stage. Ratios of ion heat conduction, convection, and turbulent heating to electron heat conduction, and ratios of electron heat convection and turbulent heating to electron heat conduction are presented for trapped-electron and trapped-ion modes. (Author)

**A79-24862** Integral invariants and quasi-MHD nonlinear dissipation. E. Minardi (EURATOM and U.K. Atomic Energy Authority, Culham Laboratory, Abingdon, Oxon, England). In: Plasma transport, heating and MHD theory; Proceedings of the

Workshop, Varenna, Italy, September 12-16, 1977.

Oxford, Pergamon Press, Ltd., 1978, p. 179-187; Discussion, p. 187-189.

A Hamiltonian approach to the derivation of integral invariants for a slightly dissipative plasma is presented. Starting from the Hamiltonian of the system of interacting particles forming a magnetized toroidal plasma, one derives a helical invariant, which can be interpreted as a helical flux in the proper limit. The existence of this invariant follows from the helical symmetry of the basic unstable magnetic process. The existence of integral invariants of the Taylor type follows from the helical invariant and a straightforward application of Liouville's theorem. These invariants are applied to the formulation of a diffusion equation for the helical flux in the cylindrical limit. A significant result is that it appears possible for the collisions to induce quasi-MHD dissipative processes which can be very rapid as a result of nonlinear effects.

P.T.H.

**A79-24863** MHD stability for a spherator with a purely poloidal magnetic field. T. Hellsten (Kungl. Tekniska Hogskolan, Stockholm, Sweden). In: Plasma transport, heating and MHD theory; Proceedings of the Workshop, Varenna, Italy, September 12-16, 1977. Oxford, Pergamon Press, Ltd., 1978, p. 191-200; Discussion, p. 201. 9 refs. EURATOM-supported research.

A localized analysis of the stability of a spherator with a purely poloidal magnetic field against MHD modes is presented. It is assumed that the closed-line concept is physically relevant for both linear equilibria and toroidal equilibria. In order to obtain a pressure distribution which decreases rapidly outwards and satisfies the closed-line interchange criterion, it is suggested that the plasma boundary be situated close to a magnetic separatrix. However, for finite beta-values, perturbations other than interchange modes may become unstable. It is found that the current density must be limited for stable equilibria, and that the maximum current density decreases rapidly in the region close to the separatrix.

P.T.H.

**A79-24864** RF-heating in stationary systems. A. D. Pillia (Akademii Nauk SSSR, Fiziko-Tekhnicheskii Institut, Leningrad, USSR). In: Plasma transport, heating and MHD theory; Proceedings of the Workshop, Varenna, Italy, September 12-16, 1977.

Oxford, Pergamon Press, Ltd., 1978, p. 205-207; Discussion, p. 208-212.

Some unsolved technical problems in the electron cyclotron resonance (ECR) and lower hybrid (LH) frequency regions are briefly mentioned. In tokamaks, an extraordinary mode launched from the outer side of the torus cannot reach the cyclotron resonance surface directly and must get around the cut-off. In low-density regions where the cyclotron resonance and upper hybrid are close together, strong absorption may occur. In real-size machines the polarization and propagation angle of the wave must be chosen carefully to avoid power absorption near the wall, but the familiar wave trajectory computations may have uncertainties in their interpretation. Two linear problems call for (1) further development of the theory of coupling between the slow wave system and the plasma, including the wave reflection and matrix boundary conditions, and (2) computation of the wave trajectories taking into account the two-dimensional toroidal effects.

P.T.H.

**A79-24865** Lower hybrid resonance heating. H. Momota (Kyoto University, Kyoto, Japan). In: Plasma transport, heating and MHD theory; Proceedings of the Workshop, Varenna, Italy, September 12-16, 1977. Oxford, Pergamon Press, Ltd., 1978, p. 213-221; Discussion, p. 221, 222. 9 refs.

Attention is called to several problems regarding linear phenomena of lower hybrid resonance heating in tokamaks. Some recent experimental results on coupling between launchers and the plasma, and on reflection of incident waves at the lower hybrid turning point, are discussed. Mechanisms of energy deposition from an applied wave are examined, and a simple model for lower hybrid resonant resonance is presented.

P.T.H.

**A79-24866** Magneto-acoustic resonance heating in the ion-cyclotron frequency domain. R. R. Weynants (Koninklijke Militaire School; Nationale Fonds voor Wetenschappelijk Onderzoek, Brussels, Belgium), V. P. Bhatnagar, P. E. Vandenplas (Ecole Royale Militaire, Brussels, Belgium), and A. M. Messiaen (Ecole Royale Militaire; Fonds National de la Recherche Scientifique, Brussels, Belgium). In: Plasma transport, heating and MHD theory; Proceedings of the Workshop, Varenna, Italy, September 12-16, 1977. Oxford, Pergamon Press, Ltd., 1978, p. 223-242.

14 refs.

With regard to the problem of heating toroidal plasmas, this paper presents a completely self-consistent calculation of the coupling of RF energy to magnetoacoustic resonances by means of coils. Simple but accurate formulas are obtained for the eigenfrequencies, coil impedance, coupling coefficients, and the absorbed power and energy. Indications are also given on how to evaluate the quality factor for various damping mechanisms in the plasma, including the mechanism due to the confluence of fast and slow waves near the ion-ion hybrid.

P.T.H.

**A79-24867** Wave propagation and absorption near the electron-cyclotron layer in the 'THOR' device C. Maroli and M. Bornatici (EURATOM and CNR, Laboratorio di Fisica del Plasma, Milan, Italy). In: Plasma transport, heating and MHD theory; Proceedings of the Workshop, Varenna, Italy, September 12-16, 1977. Oxford, Pergamon Press, Ltd., 1978, p. 243-258; Discussion, p. 259-261. 17 refs. Research supported by the Consiglio Nazionale delle Ricerche.

The paper investigates the propagation and absorption of the extraordinary mode in a plasma with parameters typical of the THOR device. The trajectories along which the injected power propagates are evaluated numerically for toroidal geometry. The spatial damping of the electron Bernstein mode generated by mode conversion of the extraordinary wave at the upper hybrid layer is then evaluated numerically for a slab with parabolic density profile and  $T(e) = 200$  eV for different values of the parallel refractive index. It is found that the lower the parallel refractive index, the nearer to the electron cyclotron layer is the site of absorption.

P.T.H.

**A79-24879** \* # Some perspectives on research into the biological response to non-ionizing electromagnetic radiation. J. C. Sharp (NASA, Ames Research Center, Moffett Field, Calif.). *Radio Science*, vol. 14, Jan.-Feb. 1979, p. 5-10.

Research on the biological effects of RF radiation in the United States has undergone a series of swings during the last three decades. The resurgence of research during the past decade is examined in the light of two projects: the proposed Space Power Station and SETI.

B.J.

**A79-25060** # Selected ordinates for total solar radiant property evaluation from spectral data. J. A. Wiebelt and J. B. Henderson (Oklahoma State University, Stillwater, Okla.). *ASME, Transactions, Journal of Heat Transfer*, vol. 101, Feb. 1979, p. 101-107. 8 refs.

The evaluation of the absorptance or transmittance of solar collector glazing materials requires knowledge of the spectral characteristics of solar irradiation (insolation). The present paper reexamines insolation at the earth's surface using the latest atmospheric data. A new and expanded set of selected ordinates is calculated. These ordinates are used to evaluate the total solar transmittance, or other related properties, for a wide variety of atmospheric conditions, from the spectral data.

S.D.

**A79-25066** # Radiant exchange for a fin and tube solar collector. T. F. Smith (Iowa University, Iowa City, Iowa) and H. Y. Lee. *ASME, Transactions, Journal of Heat Transfer*, vol. 101, Feb. 1979, p. 185-187. Research supported by the Iowa Energy Policy Council.

An analysis is presented to examine the radiant exchange phenomenon found in a fin and tube solar energy collector. It is shown that the collector efficiency depends on the tube spacing-to-

radius ratio, fin conductance, convective coefficient, absorbed solar energy, and air and surrounding surface temperatures which are used to calculate convective and radiative losses. The collector efficiency is found to increase with tube spacing and then decrease as a result of increased fin conductive resistance. Maximum collector efficiencies occur for tube spacing-to-radius ratios between 8 and 20. In particular, the efficiencies are sensitive to the values of air and surrounding surface temperatures. S.D.

**A79-25069** Angle-of-incidence effects in electron-beam-deposited SnO<sub>2</sub>/Si solar cells. T. Feng, A. K. Ghosh, and C. Fishman (Exxon Research and Engineering Co., Linden, N.J.). *Applied Physics Letters*, vol. 34, Feb. 1, 1979, p. 198; 199. 5 refs. Contract No. E(04-3)-1283.

The power-conversion efficiency of SnO<sub>2</sub>/Si solar cells fabricated by electron-beam evaporation of SnO<sub>2</sub> is strongly dependent on the angle of incidence of the SnO<sub>2</sub> vapor stream on silicon. The optimum angle of incidence is between 50 and 70 deg. Solar cells with power-conversion efficiencies exceeding 10% have been reproducibly fabricated by depositing the SnO<sub>2</sub> at angles of incidence in this optimum range. (Author)

**A79-25084** Heat exchanges and columnar growth in electron-beam evaporation of silicon films for solar cell applications. S. K. Dey, A. E. Delahoy, and W. A. Anderson (Rutgers University, Piscataway, N.J.). *Journal of Vacuum Science and Technology*, vol. 15, Sept.-Oct. 1978, p. 1739-1745. 22 refs. NSF Grant No. AER-73-03197.

Heat exchanges in electron-beam evaporation of polycrystalline Si films are studied for the first time using an electrical model. The analysis is useful for evaluating the growth kinetics of the film which influence the diameter of the columnar structure. It is shown that Si deposition causes an unsteady thermal state resulting from the radiative interaction of the substrate with the source and adjoining system parts. The calculated values of the heat exchange rates between source, substrate and enclosure, and the temperature gradient along the substrate, are in reasonable agreement with the measured parameters. Columnar films up to 27 microns in thickness, 6 microns in column diameter, and with 110-line-type preferred orientation, have been produced by e-beam deposition of Si on Al-coated substrates at temperatures ranging from 400 to 600 C. SEM micrographs are included showing columnar structure, effects of etching, and previously unreported growth features and the dependence of the column axis on the direction of the vapor stream. (Author)

**A79-25124** Evaluation of commercial catalysts for the Fischer-Tropsch reaction. W. G. Borghard and C. O. Bennett (Connecticut, University, Storrs, Conn.). *I & EC - Industrial and Engineering Chemistry, Product Research and Development*, vol. 18, Mar. 1979, p. 18-26. 21 refs. Research supported by the Electric Power Research Institute.

The hydrogenation of carbon monoxide was investigated at 20 atm (2.0 MPa) and 250 C (523 K) in tubular reactors. Four commercial iron catalysts, one commercial cobalt catalyst, and an iron lathe turning catalyst were tested at three hydrogen to carbon monoxide feed ratios. At a relatively constant space velocity the overall rates of reaction gave a good indication of activity. The cobalt catalyst appeared to be the best. Its selectivity favored saturated hydrocarbons. A nitrided ammonia synthesis catalyst attained a similar activity. An optimal feed ratio of 2:1 H<sub>2</sub>/CO was observed. The highest activities concurred with a 2:1 feed ratio and the production of water. (Author)

**A79-25138** Enhanced power generation by optical solar reflectors on geostationary spinners. P. R. K. Chetty and R. M. Vasagam (Indian Space Research Organization, Satellite Centre, Bangalore, India). *IEEE Transactions on Aerospace and Electronic Systems*, vol. AES-15, Jan. 1979, p. 119-124.

A novel arrangement is proposed to enhance the power generating capabilities of a spin stabilized geostationary satellite

(spinner). The unilluminated solar array area of the usual spinner (as sunlight falls on only one side) is illuminated by employing despun optical solar reflectors. The different mechanisms required for implementation of this arrangement are already space proven. The detailed study of this arrangement made by the authors reveals that the practical realization of this concept will enhance the power generating capability of the spinner and simultaneously reduce the weight (per unit power) and cost (per unit power) in such spinners. (Author)

**A79-25375 \*** The effect of maturation on the configuration of pristane in sediments and petroleum. R. L. Patience, S. J. Rowland, and J. R. Maxwell (Bristol, University, Bristol, England). *Geochimica et Cosmochimica Acta*, vol. 42, Dec. 1978, p. 1871-1875. 17 refs. Research supported by the Nuffield Foundation; Natural Environment Research Council Grant No. GR/3/2951; Grant No. NGL-05-003-003.

The absolute stereochemistry of pristane in a sample of contemporary marine zooplankton, Messel shale (Germany) and Djatibarang (Java) crude has been determined by gas chromatographic methods. The relative stereochemistry in Irati shale (Brazil), Green River (U.S.) crude, Halibut (Australia) crude has also been determined, and confirmed for a sample of the Green River shale. The stereoisomer distributions indicate a loss of stereospecificity of the phytol-derived 6(R), 10(S) pristane with increasing geological maturation. For example, the least mature geological sample, the Eocene Messel shale, contains solely the 6(R), 10(S) isomer, whereas a mature sample, Djatibarang crude, contains 50% of the 6(R), 10(S) isomer and 25% of each of the 6(R), 10(R) and 6(S), 10(S) isomers. (Author)

**A79-25392** On the use of synoptic weather map typing to define solar radiation regimes. P. W. Suckling (Brandon University, Brandon, Manitoba, Canada) and J. E. Hay. *Monthly Weather Review*, vol. 106, Nov. 1978, p. 1521-1531. 16 refs. Research supported by the Department of the Environment and National Research Council of Canada.

A synoptic approach to the analysis of solar radiation regimes is undertaken with the aim of developing a synoptic solar radiation climatology. Synoptic weather types for an area including British Columbia and the adjacent regions of the northeastern Pacific are defined using an objective correlation classification technique. These weather types are shown to determine statistically distinct solar radiation distributions. However, further analysis shows that the distinctiveness of the solar radiation regimes is not sufficient to be used in practical applications such as interpolation between measurement stations, estimation of solar radiation inputs in the absence of observed data or in the explanation of the interannual variability of solar radiation. As a result, attempts to base a solar radiation climatology solely on the synoptic regimes defined using the readily available data and techniques employed in this study are not justified. However, the statistical analyses do suggest that the use of more appropriate synoptic data and typing techniques may overcome many of the inadequacies in the present study. (Author)

**A79-25522** Selective covers for natural cooling devices. A. Addeo, E. Monza, M. Peraldo (Montedison S.p.A., Italy), B. Bartoli, B. Coluzzi, V. Silvestrini, and G. Troise (Napoli, Università, Naples, Italy). *Nuovo Cimento C, Serie 1*, vol. 1C, Sept.-Oct. 1978, p. 419-429.

Extraatmospheric space is practically a pure sink of radiation, and can be used as a nonconventional energy source. In previous papers we have shown that surfaces with an emissivity matched with the atmospheric 8-13-micron 'transparency window' (natural emitters) interact with cold space when exposed to clear sky at night, and undergo a sizable cooling effect. In this paper, starting from experimental results concerning the diurnal performances of natural emitters, the problem of their interaction with solar radiation is discussed, and the use of selective covers which shade the emitter from solar radiation, without preventing the interaction with cold space via emission of infra-red radiation is proposed. (Author)



**A79-25548** Highly efficient quantum conversion at chlorophyll a-lecithin mixed monolayer coated electrodes. T. Miyasaka, T. Watanabe, A. Fujishima, and K. Honda (Tokyo, University, Tokyo, Japan). *Nature*, vol. 277, Feb. 22, 1979, p. 638-640. 15 refs.

Miyasaka et al. (1978) have tried to combine different approaches to the design of solar conversion systems based on photo-synthetic primary reactions by using a chlorophyll (Chl) a-coated  $\text{SnO}_2$  transparent electrode as a photoanode. A maximum photocurrent quantum efficiency of 12-16% was attained with Chl a-stearic acid mixed monolayer systems. However, in this case a decrease of the quantum efficiency was observed at Chl a-stearic acid molar ratios of less than 1.0. A description is presented of an investigation in which these problems were overcome with the aid of an approach in which a phospholipid was used in place of fatty acid as a diluent for a Chl a monolayer. G.R.

**A79-25605 #** Energy for Europe from space. D. Kassing and K. K. Reinhartz (ESA, Spacecraft Power Supplies Div., Noordwijk, Netherlands). *ESA Journal*, vol. 2, no. 3, 1978, p. 179-187. 20 refs.

The European role in the development of the solar power satellite (SPS) concept is discussed. Numerous technical and economic studies have shown that, in principle, this concept can compete economically with other alternative advanced energy sources. The SPS has a major operational advantage over other solar energy conversion schemes in that it can deliver base-load electrical energy almost constantly with the exception of a small number of shadow periods (totalling less than one percent per year) and it can also economically supply areas which have little sunshine but a highly developed industry. B.J.

**A79-25720** An analytical expression for the specific output of wind turbine generators. J. Asmussen, G. L. Park (Michigan State University, East Lansing, Mich.), and D. Manner (Central Solar Energy Research Corp., Detroit, Mich.). *IEEE, Proceedings*, vol. 66, Oct. 1978, p. 1295, 1296; Comments, p. 1296, 1297, 1298; Reply, p. 1297, 1298. 5 refs. Research supported by the Central Solar Energy Research Corp.; Contract No. EG-77-5-52-4450.

Using a Rayleigh distribution for the wind speed frequency distribution, an analytical expression for wind turbine generator specific output is derived and expressed in terms of machine characteristics and mean wind speed. Results are expressed as a family of curves which are functions of the cut-in, rated, and cut-out wind speeds. The results are compared with numerical calculations using actual wind records and with the specific output curve of Harder (1977). (Author)

**A79-25744** High-efficiency thin-film polycrystalline-silicon solar cells. T. L. Chu, S. S. Chu, C. L. Lin, and R. Abderrassoul (Southern Methodist University, Dallas, Tex.). *Journal of Applied Physics*, vol. 50, Feb. 1979, p. 919-921. 9 refs. Contract No. EY-76-C-03-1285.

The deposition of a silicon film containing a p-n junction on a metallurgical silicon substrate has been used for the preparation of thin-film silicon solar cells. The substrate was prepared by the unidirectional solidification of purified metallurgical silicon on a graphite plate, and the silicon film was deposited by the thermal reduction of trichlorosilane with hydrogen containing appropriate dopants. Solar cells of the p(+)/n/n(+)-metallurgical silicon/graphite configuration have been prepared, and the AM1 efficiencies of 9-10 sq cm area cells are up to 9.5%. (Author)

**A79-25745** Series resistance effects in  $\text{GaAlAs/GaAs}$  concentrator solar cells. S. Charan, M. Konagai, and K. Takahashi (Tokyo Institute of Technology, Tokyo, Japan). *Journal of Applied Physics*, vol. 50, Feb. 1979, p. 963-968. 13 refs.

In the present paper, the series resistance of Zn-doped p-(GaAl)As/p-GaAs/n-GaAs solar cells prepared by liquid-phase epitaxy is calculated as a function of the sheet resistance of p-(GaAl)As and p-GaAs. The resistivity of such cells is found to be two times that of

Zn-diffused p-GaAs. The high resistivity of p-Ga0.3Al0.7As is attributed to the fact that the Zn acceptor level is deeper seated in Ga0.3Al0.7As than in p-GaAs. In the experimental portion of the study, it proved possible to reduce the series resistance by using fine grid patterns. V.P.

**A79-25746** Selective absorption of solar energy in ultra-fine metal particles - Model calculations. C. G. Granqvist (Chalmers Tekniska Hogskola, Goteborg, Sweden) and O. Hunderi (Norges Tekniske Hogskole, Trondheim, Norway). *Journal of Applied Physics*, vol. 50, Feb. 1979, p. 1058-1065. 54 refs.

Spectral reflectance from metal surfaces with coatings of ultra-fine metal particles dispersed in an insulating medium is computed. This model is appropriate to several kinds of selective absorbers for efficient photothermal conversion of solar energy. The main interest lies in the parameters which govern  $\lambda(c)$ , the wavelength below which the surfaces are good absorbers and above which they are good reflectors. The roles of coating thickness, substrate metal, particle shape and orientation, possible dielectric permeability (real and imaginary parts) of the embedding medium and of graded volume fractions of metal are analyzed. A particularly interesting result is that an enhanced eccentricity of the particles is, under most conditions, highly effective for shifting  $\lambda(c)$  towards longer wavelengths. A similar shift is also found for spherical metallic shells surrounding dielectric cores of increasing size. (Author)

**A79-25748** The short-wavelength response of MIS solar cells. M. A. Green (New South Wales, University, Kensington, Australia). *Journal of Applied Physics*, vol. 50, Feb. 1979, p. 1116-1122. 15 refs. Research supported by the Australian Research Grants Committee, Utah Foundation, Electrical and Radio Research Board of Australia, and Sydney County Council.

With certain combinations of insulator thickness, surface-state density, and barrier height, it is shown that a dead layer can extend up to 750 Å into the semiconductor in MIS and Schottky solar cells. This can cause a fall off in short-wavelength response of the cell. Recombination at surface states can cause an additional fall off in spectral response at all wavelengths. By ensuring that the semiconductor surface is strongly inverted, these effects can be minimized and all carriers optically generated near the surface collected. This is confirmed by experimental measurements on Al/SiO(x)/p-Si MIS cells with particular attention focused on the 330-500-nm wavelength range. (Author)

**A79-25852 \* #** Space reflector technology and its system implications. K. W. Billman, W. P. Gilbreath (NASA, Ames Research Center, Moffett Field, Calif.), and S. W. Bowen (Beam Engineering, Inc., Sunnyvale, Calif.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 15th, Washington, D.C., Feb. 6-8, 1979, Paper 79-0545*. 18 p. 18 refs.

The technical feasibility of providing nearly continuous solar energy to a world-distributed set of conversion sites by means of a system of orbiting, large-area, low-area-density reflecting structures is examined. Requisite mirror area to provide a chosen, year-averaged site intensity is shown. A modeled reflector structure, with suitable planarity and ability to meet operational torques and loads, is discussed. Typical spatial and temporal insolation profiles are presented. These determine the sizing of components and the output electric power from a baselined photovoltaic conversion system. Technical and economic challenges which, if met, would allow the system to provide a large fraction of future world energy needs at costs competitive to circa-1995 fossil and nuclear sources are discussed. (Author)

**A79-25854 \* #** The solar power satellite concept - The past decade and the next decade. C. C. Kraft, Jr. (NASA, Johnson Space Center, Houston, Tex.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 15th, Washington, D.C., Feb. 6-8, 1979, Paper 79-0534*. 18 p. 24 refs.



Results of studies on the solar power satellite concept, currently under evaluation by NASA and the Department of Energy, are summarized. The basic advantages provided by the concept are the near-continuous access to sunlight and the freedom from atmospheric effects and cloud cover. The systems definition studies have considered photovoltaic and thermal energy conversion systems and found both to be technically feasible, with the photovoltaic approach being currently preferred. A microwave test program is under way which will provide quantitative data on critical parameters, including beam forming and steering accuracy. Ballistic and winged launch vehicles have been defined for the transportation of construction materials, with the Shuttle expected to provide low-cost transportation to and from space. A reference system has been outlined for evaluating the concept in terms of environmental and other considerations. Preliminary estimates of natural resource requirements and energy payback intervals are encouraging. A.A.

**A79-25860 #** A test bed for thermosyphon solar air collectors. W. Lowry (Northern Arizona University, Flagstaff, Ariz.) and D. Pearson (L.S.W.B. Engineers, San Diego, Calif.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 15th, Washington, D.C., Feb. 6-8, 1979, Paper 79-0541.* 7 p. 8 refs.

A description of solar 'thermosyphon' air heating systems (those with no active circulating devices) is presented. Utilizing similar water system analyses, a model is developed to predict mass flow rates and mean system temperatures. Studies indicate the effects of various system geometries, glazing configurations, and frictional head losses. A test bed design is presented to provide experimental verification of these predictions. Consisting of two closed-loop air thermosyphon collectors, the bed will supply data for calculations of instantaneous efficiencies as a basis for comparing the effects of these parameter variations. (Author)

**A79-25871 \*** An approach to automated longwall mining. E. R. Palowitch (U.S. Department of Energy, Pittsburgh Mining Technology Center, Pittsburgh, Pa.) and P. H. Broussard, Jr. (NASA, Marshall Space Flight Center, Huntsville, Ala.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 15th, Washington, D.C., Feb. 6-8, 1979, Paper 79-0532.* 9 p. 7 refs.

The longwall system of mining coal, providing advantages in the areas of productivity as well as health and safety, is described, and technological developments leading to a full automation of the system are discussed. In the longwall system large blocks of coal (up to 600 feet wide and up to 5000 feet long) are developed, with each block mined out by taking successive slices across the short dimension of the block and loading the broken coal onto a conveyor. A self-advancing system supports the roof over the length of the face throughout cutting and loading, with the supports advanced with the face, and the roof allowed to collapse behind them. A double-ranging drum longwall shearer provides the system with an efficient yaw, roll, and variable-thickness vertical control. Currently two machine operators function as error detectors and controllers. It is shown that electronic sensors can lead to a fully automated vertical control system, and automatic roll control is achievable with available instruments and machine tilt actuators. A.A.

**A79-25892** Environmental factors affecting the installation and operation of gas turbine engines in agricultural aircraft. G. M. Hogg (Pratt and Whitney Aircraft of Canada, Ltd., Longueuil, Quebec, Canada). *Society of Automotive Engineers, Aerospace Meeting, San Diego, Calif., Nov. 27-30, 1978, Paper 781010.* 17 p. 6 refs.

The operational and economic environments associated with agricultural aircraft have dictated several changes to basic turbine engine installation procedures. As the ingestion of chemicals can cause rapid distress in the engine hot section, intake systems are proposed. Aircraft missions are analyzed, and the effect of high cycle time on major rotating components explained. In addition, with jet fuel seldom available at remote fields, alternates such as diesel and

gasoline - together with their limitations - are dealt with. Operational data is reviewed, recent studies and developments outlined, and the future of the gas turbine engine in agricultural aircraft discussed.

(Author)

**A79-25899** Effects of fuel properties on soot formation in turbine combustion. D. W. Naegeli and C. A. Moses (U.S. Army, Fuels and Lubricants Research Laboratory, San Antonio, Tex.). *Society of Automotive Engineers, Aerospace Meeting, San Diego, Calif., Nov. 27-30, 1978, Paper 781026.* 11 p. 25 refs. Grant No. DAAK70-78-C-0001; Contract No. N00140-77-C-1345.

A combustor rig instrumented for measuring flame radiation, exhaust smoke, and gaseous emissions is used to study the sensitivity of combustor performance to the physical and chemical properties of fuels used in turbine combustion. These fuels include petroleum-base jet fuels, JP-5 syncrudes, water-fuel emulsions, and hybrid aromatic/methanol solutions. Examination of the effects of aromatic content, ring carbon content, and hydrogen-to-carbon (H/C) ratio on the flame radiation and exhaust smoke reveals that H/C ratio is the most effective indicator of soot formation. There is no observed effect of viscosity and end point on flame radiation and smoke. It is suggested that the mechanism for soot formation in the turbulent diffusion flame of a turbine combustor is due to gas-phase reactions and essentially independent of molecular structure. Water appears to play an important chemical role in soot reduction, probably as an additional source of hydrogen. S.D.

**A79-25900** Shale oil - The answer to the jet fuel availability question. L. C. Angello, A. V. Churchill, C. L. Delaney, and H. R. Lander (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, Ohio). *Society of Automotive Engineers, Aerospace Meeting, San Diego, Calif., Nov. 27-30, 1978, Paper 781027.* 11 p.

The Air Force began in 1974 a program to investigate the possibility of using alternative domestic liquid hydrocarbons, primarily shale oil, as sources for the standard jet fuel, JP-4, in order to ensure adequate fuel availability at an acceptable cost. The paper discusses the results of this program and its future goals. Results of processing studies on alternative hydrocarbon sources from shale oil are presented; it is found that shale oil processing resulted in specification turbine fuel when hydrotreated at 1500 psi, while coal liquids failed to meet specifications even when hydrotreated to 2200 psi. Fuel derived from shale oil was also found to be economically competitive under proper conditions. Results from shale oil-derived fuel combustion studies are presented, showing the effects of hydrogen and nitrogen content on combustor liner temperature, smoke and NOx emission. A projection of future specifications of Air Force aviation fuels is then presented. A.L.W.

**A79-25917 \*** Evaluation of the application of some gas chromatographic methods for the determination of properties of synthetic fuels. A. C. Antoine (NASA, Lewis Research Center, Cleveland, Ohio). *Society of Automotive Engineers, Aerospace Meeting, San Diego, Calif., Nov. 27-30, 1978, Paper.* 45 p. 6 refs.

The purpose of the investigation was to evaluate the applicability, to some synthetic fuels, of some gas chromatographic methods now under development for use with petroleum based fuels. Thirty-two jet and diesel fuel samples which were prepared from oil shale and coal syncrudes were examined. The boiling range distribution of each was determined by gas chromatography, and from that data distillation properties were calculated. The calculated results gave sufficient agreement with the measured values that the equations could be useable in their present form. Bulk fuel properties were calculated for the 16 JP-5 and Diesel No. 2 type fuels. The results show that the equations would not give useable results. Capillary column gas chromatography was used to determine the n-alkane content of the eight JP-5 type samples and the results related to the observed freezing points. The results show that the concentrations of the long straight chain molecules in the fuels exert influence on the freezing point but are not the complete controlling factor. (Author)

**A79-25926** International Solar Energy Conference on the Performance of Solar Heating and Cooling Systems, Düsseldorf, West Germany, April 19, 20, 1978, Proceedings. Conference sponsored by NATO and International Solar Energy Society. Edited by F. A. Peuser (Kernforschungsanlage Jülich GmbH, Jülich, West Germany). Düsseldorf, West Germany, International Solar Energy Society, 1978. 373 p. (NATO/CCMS-85) \$15.90.

The papers report experience gained during the operation of various types of solar houses and pilot buildings using at least partial solar space heating and cooling and service water heating throughout the year. Topics studied include passive solar heating of buildings, a solar air heating and nocturnal cooling system, the Dornier/RWE solar house in Essen, the Mississauga solar house (Canada), the Thomson solar house (New Zealand), the Eindhoven solar house (The Netherlands), the zero energy house in Denmark, a passive solar heating system in Turkey, the Santa Clara Community Center Project, and a solar heated outdoor swimming pool. P.T.H.

**A79-25927** What and where - Solar active systems or energy conservation in buildings. R. Bruno and H. Hörster (Philips GmbH, Forschungslaboratorium, Aachen, West Germany). In: International Solar Energy Conference on the Performance of Solar Heating and Cooling Systems, Düsseldorf, West Germany, April 19, 20, 1978, Proceedings. Düsseldorf, West Germany, International Solar Energy Society, 1978, p. 1-37.

This paper introduces a methodology which can be used to assist in choosing what to use where: solar active and/or energy conservation to reduce the use of conventional energy sources. It is shown that the particular set of choices made depends on location. Results are given for 'what and where' in this paper for four locations in Europe between latitudes 43 N to 58 N and three locations in the US from 35 N to 46 N. (Author)

**A79-25928** Passive solar heating of buildings. J. D. Balcomb, J. C. Hedstrom, and R. D. McFarland (California, University, Los Alamos, N. Mex.). In: International Solar Energy Conference on the Performance of Solar Heating and Cooling Systems, Düsseldorf, West Germany, April 19, 20, 1978, Proceedings. Düsseldorf, West Germany, International Solar Energy Society, 1978, p. 39-57. 9 refs. ERDA-sponsored research.

Passive solar heating concepts - in which the thermal energy flow is by natural means - are described according to five general classifications: direct gain, thermal storage wall, solar greenhouses, roof ponds, and convective loops. Examples of each are discussed. Passive test rooms built at Los Alamos are described and results are presented. Mathematical simulation techniques based on thermal network analysis are given together with validation comparisons against test room data. Systems analysis results for 29 climates are presented showing that the concepts should have wide applicability for solar heating. (Author)

**A79-25929** Prospects for solar heating and cooling in the United States. F. H. Morse (U.S. Department of Energy, Solar Heating and Cooling Research and Development Branch, Washington, D.C.). In: International Solar Energy Conference on the Performance of Solar Heating and Cooling Systems, Düsseldorf, West Germany, April 19, 20, 1978, Proceedings. Düsseldorf, West Germany, International Solar Energy Society, 1978, p. 59-64.

The paper examines the prospects for solar heating and cooling in the U.S. by giving a summary of the solar heating and cooling program of the Federal Government and presenting the main results of a recent analysis of the economics of water and space heating. Objectives of the Government program are to (1) conduct research and development on reducing solar heating and cooling system costs and improve their performance, (2) collect, evaluate, and disseminate data on technical, environmental, and socioeconomic aspects of solar energy, and (3) demonstrate solar heating technology and cooling in new and existing buildings by 1979. It has been proved that solar heating is now economically competitive with electricity as is passive solar space heating. Extensive efforts to develop a sound market for

solar energy systems and products are being made. Economic criteria for feasibility of solar heating and cooling in residences have been developed. It was shown that enactment of a solar tax credit would have a dramatic positive effect on solar economic feasibility for detached residences. P.T.H.

**A79-25930** The CCMS solar energy pilot study system performance reporting format. R. Allen (Maryland, University, College Park, Md.). In: International Solar Energy Conference on the Performance of Solar Heating and Cooling Systems, Düsseldorf, West Germany, April 19, 20, 1978, Proceedings. Düsseldorf, West Germany, International Solar Energy Society, 1978, p. 65-78.

The paper gives an outline of the format recommended by the Committee on the Challenges of Modern Society for reporting the results of pilot studies of solar heating and cooling systems. The objective of the format is to assure that sufficient information is provided to enable the reader to make his own assessment of the performance of a solar heating and/or cooling system and to relate that performance, which was achieved in one particular climate and economic environment, to a different climate and economic environment. The reports should include environmental data, such as tables of monthly averages of (1) percent of sunshine or cloud cover fraction, (2) mean daily solar radiation on surface of specified orientation, and (3) ambient temperature. The system description should include building characteristics, collector characteristics, hot-side storage characteristics, cold-side characteristics, and cooling unit characteristics. The system thermal performance summary should include solar energy incident on collector plane, solar energy to hot-side storage, solar energy to space heating, heat recovery subsystem heat to space heating, solar energy to cooling, and percent of heating and service hot water provided by solar energy. Economic data should include labor, material, and total operating costs. P.T.H.

**A79-25931** Solar heating, cooling and hot water production - A critical look at CCMS installations. R. Bruno (Philips GmbH, Forschungslaboratorium, Aachen, West Germany) and W. S. Duff (Colorado State University, Fort Collins, Colo.). In: International Solar Energy Conference on the Performance of Solar Heating and Cooling Systems, Düsseldorf, West Germany, April 19, 20, 1978, Proceedings. Düsseldorf, West Germany, International Solar Energy Society, 1978, p. 79-94. 6 refs.

The paper discusses the reports on a year's performance of 17 representative experimental solar heating, cooling and/or hot water production installations located mostly in North America and Europe. System efficiencies were found to be a good measure of comparison for installations in different climates. Significant differences in system efficiencies, due primarily to differences in systems, are reflected by a special grouping of the load and insolation parameters. Results indicate that the presence of evacuated tubular collectors in a system translates into a substantial performance advantage over all other systems analyzed. A heat pump arrangement and an air system showed outstanding performance. P.T.H.

**A79-25932** Solar air heating and nocturnal cooling system /CSU Solar House II/. S. Karaki (Colorado State University, Fort Collins, Colo.). In: International Solar Energy Conference on the Performance of Solar Heating and Cooling Systems, Düsseldorf, West Germany, April 19, 20, 1978, Proceedings. Düsseldorf, West Germany, International Solar Energy Society, 1978, p. 95-129.

The heating system of the solar house is an air-heating system with an auxiliary gas duct furnace. The solar system consists of air heating collectors, pebble-bed storage, ducts of various sizes, a blower with constant speed motor, and automatic controls to collect, store and deliver solar heat to the building space. During the partial 1975-1976 heating season, the system provided 35,500 MJ of heat from the solar system which was 71% of the total load for the period recorded. Annual fractions are within the target design point of about 70% of the annual loads. The nocturnal cooling system had limited cooling capacity. Air leaks in the upper manifold of the

collectors resulted in that the air flow through the collector was less than designed, so heat losses from the collector were greater than expected. P.T.H.

**A79-25933** Dornier/RWE solar house in Essen, FRG. K. Speidel (Dornier System GmbH, Friedrichshafen, West Germany) and J. Brosch (Rheinisch-Westfälisches Elektrizitätswerk, Essen, West Germany). In: International Solar Energy Conference on the Performance of Solar Heating and Cooling Systems, Düsseldorf, West Germany, April 19, 20, 1978, Proceedings. Düsseldorf, West Germany, International Solar Energy Society, 1978, p. 131-139.

A year's data on the performance of a solar residential heating system in Essen, West Germany, are reported and discussed. The house was equipped with an active solar collector area of 65 sq m, seven storage tanks, a heat pump, and systems for control and measurement. The main operating modes of the system are (1) warming up the hot water storages, (2) warming up the storage tanks for heating, and (3) low temperature energy storage. The energy gained by the solar system was calculated to be 19,950 kWh in 1976 (52% of the energy needed). Monthly averages for total radiation on the collector field, auxiliary heating needed, electric energy for the heat pump, and total additional energy are given. The results indicate high efficiency of the system, although the cost is still excessive. P.T.H.

**A79-25934** Experience with the MBB-solar testing house at Otterfing and relevant consequences on the commercial product. H. K. H. Grallert (Messerschmitt-Bölkow-Blohm GmbH, Ottobrunn, West Germany). In: International Solar Energy Conference on the Performance of Solar Heating and Cooling Systems, Düsseldorf, West Germany, April 19, 20, 1978, Proceedings. Düsseldorf, West Germany, International Solar Energy Society, 1978, p. 141-160.

The paper reports experience with a solar heating system for a one-family prefabricated pre-alpine type house near Munich, West Germany. The collector area consists of double-glass flat plate collectors with 80 sq m effective area. Solar heat storage is provided by 8 cu m hot water storage tanks and soil storage compartments below the cellar floor. The design heat load per unit design temperature difference was 1.53 MWh/K-yr. Data presented include monthly energy distribution (heat demand for space heating and hot water supply, solar heat input to storage, and solar heat output), hot water storage temperature, actual and predicted monthly insolation, actual and predicted monthly energy demand, and actual and predicted monthly energy and oil savings for different operating modes. Despite unfavorable operating conditions during the first year of operation, the solar heating system saved 80% of the predicted annual oil demand. P.T.H.

**A79-25935** Mississauga solar house /Mississauga, Ontario, Canada/. J. R. Sasaki (National Research Council, Ottawa, Canada). In: International Solar Energy Conference on the Performance of Solar Heating and Cooling Systems, Düsseldorf, West Germany, April 19, 20, 1978, Proceedings. Düsseldorf, West Germany, International Solar Energy Society, 1978, p. 161-172.

The paper reports on a project designed to demonstrate the technical feasibility of using a solar heating system with a water/air heat pump to provide a part of the space and service water heating requirements of a single-family home under Canadian climatic conditions. The solar collection system consists of 64.4 sq m of flat-plate water heating collectors surface mounted on the roof, and two concrete tanks containing a total of 18 cu m of water in the basement. A complete electric backup heating system was provided. The monthly average fraction of solar energy in the total energy supplied varied from 31% in January to 61% in June. For a one-year period the average fraction solar was 42% of the total space and service water heating requirement. The total solar energy used in November and December exceeded the solar energy collected in the same period, which demonstrates the seasonal carry-over feature of the heat storage unit. P.T.H.

**A79-25936** Thomson Solar House I. S. W. Thomson (Dimond Industries, Ltd., Wellington, New Zealand). In: International Solar Energy Conference on the Performance of Solar Heating and Cooling Systems, Düsseldorf, West Germany, April 19, 20, 1978, Proceedings. Düsseldorf, West Germany, International Solar Energy Society, 1978, p. 173-186. 9 refs.

A solar house built near Wellington, New Zealand, where the average home must be heated 50% of the year, is described. A 37 sq m glass roof is designed over an internal courtyard room, where the internal glass walls act as the second glass cover on a solar collector and the floor acts as the heat sink. The active part of the system consists of a 33 sq m vertical flat plate collector. Water is the heat transfer medium, effecting a straight exchange to copper floor coils. The system provides 50% of heating requirements. Low temperature collection proved the more efficient. Annealed copper tube circuits have had no maintenance problem over ten years. P.T.H.

**A79-25937** Solar houses in Blagnac /Blagnac, Haute-Garonne, France/. J. P. Marié (Secrétariat Permanent du Plan-Construction, Paris, France) and B. Bourret (Institut National des Sciences Appliquées, Toulouse, France). In: International Solar Energy Conference on the Performance of Solar Heating and Cooling Systems, Düsseldorf, West Germany, April 19, 20, 1978, Proceedings. Düsseldorf, West Germany, International Solar Energy Society, 1978, p. 187-200.

The paper reports on the relative performances of eight solar houses near Toulouse, France: five dwellings of 277 cu m, equipped with a large solar collector of 30 sq m area, where space heating and service hot water are provided by solar and gas energy; and three dwellings of 257 cu m, equipped with 3.5 sq m collectors for service hot water, the house being heated with gas. For the space heating experiment, the collectors were inclined 15 deg, and the heat distribution was by means of air. In the service hot water systems, water is pumped onto the top of the collectors, from where it flows down. Over a six-month period from December to May a global gain of 26 percent for all systems was noted. The percent of heating provided by solar energy ranged from 12 percent in December to 45 percent in April. P.T.H.

**A79-25938** The performance of the heating system in the solar house of the Eindhoven University of Technology. C. W. J. van Koppen and J. P. S. Thomas (Eindhoven, Technische Hogeschool, Eindhoven, Netherlands). In: International Solar Energy Conference on the Performance of Solar Heating and Cooling Systems, Düsseldorf, West Germany, April 19, 20, 1978, Proceedings. Düsseldorf, West Germany, International Solar Energy Society, 1978, p. 201-215.

The integrated solar house at Eindhoven, The Netherlands, has a solar roof tilted at an angle of 48 deg consisting of 51 sq m of aluminum finned tube absorber plates coated with black chrome. In the 4.1 cu m solar heat storage tank the advantages of thermal stratification are exploited to the limits of their potential. For example, the return flow from the collectors enters the storage via a floating inlet, a thin-walled flexible hose that automatically moves to the level in the tank where the temperature is equal to the collector exit temperature. Fresh intake air for the ventilation of the house passes along the bottom of the tank, thereby cooling the water there and itself being preheated. Over a one-year period a total of 12,492 kWh of solar heat was used, as compared with the 30,447 kWh of net heat for heating and hot water required. A fuel savings of 1900 cu m of natural gas is calculated. P.T.H.

**A79-25939** Performance of residential solar heating and cooling system with flat-plate and evacuated tubular collectors - CSU Solar House I. W. S. Duff, T. M. Conway, G. O. G. Löf, D. B. Meredith, and R. B. Pratt (Colorado State University, Fort Collins, Colo.). In: International Solar Energy Conference on the Performance of Solar Heating and Cooling Systems, Düsseldorf, West Germany, April 19, 20, 1978, Proceedings.

Düsseldorf, West Germany, International Solar Energy Society, 1978, p. 217-230. Research supported by the U.S. Department of Energy.

Solar House I measurements have provided comparison data on space heating, water heating, and cooling by systems in which flat-plate collectors and evacuated tube collectors were used. A system comprising an evacuated tubular collector, lithium bromide absorption water chiller, and associated equipment was found to be highly effective in providing space heating and cooling to a small building. This system was able to supply twice the space heating and several times the cooling obtainable from an equal occupied area of good quality flat-plate collectors. A greater fraction of the domestic hot water can be obtained by supplying its heat from main storage. P.T.H.

**A79-25940** CCMS solar energy pilot study reporting format - The zero energy house in Denmark. T. V. Esbensen and V. Korsgaard (Danmarks Tekniske Højskole, Lyngby, Denmark). In: *International Solar Energy Conference on the Performance of Solar Heating and Cooling Systems*, Düsseldorf, West Germany, April 19, 20, 1978, Proceedings. Düsseldorf, West Germany, International Solar Energy Society, 1978, p. 231-248.

The paper deals with the design of an experimental single-family solar house consisting of two dwelling units of 60 sq m each and a 70 sq m atrium. The feasibility of utilizing a solar heating system with seasonal heat storage for heating and hot water supply is demonstrated for climatic conditions typical of Denmark. V.P.

**A79-25941** The Philips experimental house - A system's performance study. R. Bruno, W. Hermann, H. Hörster, R. Kersten, K. Klinkenberg (Philips GmbH, Forschungslaboratorium, Aachen, West Germany). In: *International Solar Energy Conference on the Performance of Solar Heating and Cooling Systems*, Düsseldorf, West Germany, April 19, 20, 1978, Proceedings. Düsseldorf, West Germany, International Solar Energy Society, 1978, p. 249-263.

The present paper deals with a theoretical and experimental study of means of energy conservation with emphasis on solar energy utilization. An experimental house constructed on the basis of this study incorporates such features as thorough thermal insulation of walls and windows, controlled air ventilation, heat recovery from exhaust air and waste water, utilization of heat pumps in various modes of operation, and utilization of solar energy by means of evacuated selective solar collectors. V.P.

**A79-25942** Passive solar heating system in Turkey. A. G. Mutdogan (Ministry of Energy and Natural Resources, Dept. of Energy, Ankara, Turkey). In: *International Solar Energy Conference on the Performance of Solar Heating and Cooling Systems*, Düsseldorf, West Germany, April 19, 20, 1978, Proceedings. Düsseldorf, West Germany, International Solar Energy Society, 1978, p. 265-280.

The paper deals with a four-year solar heating program initiated in June 1977 to develop solar houses appropriate for the climatic conditions prevailing in Turkey. The design and characteristics of four solar house versions are discussed. These are houses with solar heating but without electricity and running water; houses with solar heating and electricity but without running water; houses with solar heating and cooling, running water, and electricity; and apartment buildings with solar heating and cooling. V.P.

**A79-25943** Passive solar house in Vetlanda - Interim report. E. Öfverholm (Kungl. Tekniska Högskolan, Stockholm, Sweden). In: *International Solar Energy Conference on the Performance of Solar Heating and Cooling Systems*, Düsseldorf, West Germany, April 19, 20, 1978, Proceedings. Düsseldorf, West Germany, International Solar Energy Society, 1978, p. 281-289.

The thermal performance of a passive solar heating system in a house in Vetlanda, Sweden is reported. Heating is provided by south windows and stored by a concrete slab foundation. Excessive interior temperatures are avoided by means of room thermostats, a variable air flow ventilation system and fixed solar screening. Heat losses are

reduced by thermal insulation (190mm in the walls and 300mm in the roof) and insulating four-pane windows. The solar energy collected from October 1976 to April 1977 was calculated from values measured by pyranometers behind the windows and from the difference between heat loss and auxiliary energy consumed. It is concluded that the solar contribution to space heating has been poor, due to less insolation than normal, excessive window shading, the inability of the system to collect all available solar energy on clear days and lower than normal ambient temperatures. A computer simulation may help to solve problems of optimal window shading and thermal measurements are being continued. A.L.W.

**A79-25944** Solar heating and cooling performance of the Los Alamos National Security and Resources Study Center. H. S. Murray, J. C. Hedström, and J. D. Balcomb (California, University, Los Alamos, N. Mex.). In: *International Solar Energy Conference on the Performance of Solar Heating and Cooling Systems*, Düsseldorf, West Germany, April 19, 20, 1978, Proceedings. Düsseldorf, West Germany, International Solar Energy Society, 1978, p. 291-316. Research sponsored by the U.S. Department of Energy.

The solar heating, cooling and ventilation systems of the National Security and Resources Study Center at the Los Alamos Scientific Laboratory are discussed. The building, designed to conserve energy is heavily insulated. The heating, ventilation and air conditioning system, which makes use of air recirculation, heat recovery and complete shutdown at night, is a two-zone (perimeter and interior) variable air volume system with separate supply fans and cooling coils for each zone. The energy system consists of a single, roof-mounted solar collector array and heat exchanger, two storage tanks, and two water chillers - a lithium bromide absorption chiller and a Rankine cycle unit. Monthly and daily summaries of the system's thermal performance are presented for the heating season of November 1977 to April 1978, along with monthly summaries for the August through September 1977 cooling season. The solar energy contribution to heating or cooling ranged from 63% in January to 99% in April. Thermal performance characteristics of the solar collector, heat transfer, heat storage and air conditioning subsystems are also presented. A.L.W.

**A79-25945** Santa Clara Community Center Project, USA. M. Hensch, S. Ayraud, and W. Niemeyer (Santa Clara, University, Santa Clara, Calif.). In: *International Solar Energy Conference on the Performance of Solar Heating and Cooling Systems*, Düsseldorf, West Germany, April 19, 20, 1978, Proceedings. Düsseldorf, West Germany, International Solar Energy Society, 1978, p. 317-330.

The paper presents the results of a year's operation of the solar space heating and cooling and service water heating system of the Santa Clara Center, a facility with 2500 sq cm net interior area. The solar system was sized to meet a peak heating load of 3060 MJ/day and a peak cooling load of 6220 MJ/day. The priority for use of the solar energy is first to drive the chillers and then to provide heating energy to the building or hot storage. The collectors are double glazed with selectively coated flat roll bond copper absorber plates. Monthly and annual values of the mean daily heat flows are presented. The percent solar contribution to the energy requirements of the building ranged from 24.5% in December to 78.9% in May. The total gas energy saved over one year was 122.3 billion J, while the system required a total of 19.9 billion J of electric energy more than the equivalent nonsolar system. P.T.H.

**A79-26038** Oxidation of SO<sub>2</sub> on the surface of fly ash particles under low relative humidity conditions. Y. Mamane (NOAA, Atmospheric Physics and Chemistry Laboratory, Boulder, Colo.; Technion - Israel Institute of Technology, Haifa, Israel) and R. F. Pueschel (NOAA, Atmospheric Physics and Chemistry Laboratory, Boulder, Colo.). *Geophysical Research Letters*, vol. 6, Feb. 1979, p. 109-112. 9 refs. Research supported by the U.S. Environmental Protection Agency.

**A79-26131 \* #** Photovoltaic power systems for rural areas of developing countries. L. Rosenblum, W. J. Bifano, G. F. Hein, and A. F. Ratajczak (NASA, Lewis Research Center, Cleveland, Ohio). *United Nations, International Seminar on Solar Energy, Tokyo, Japan, Feb. 5-10, 1979, Paper. 18 p. 9 refs.*

Photovoltaic (PV) applications for rural areas of underdeveloped countries are discussed in relation to PV system technology, reliability, and present and projected cost. The information presented is derived mainly from NASA, Lewis Research Center experience with PV systems deployed with a variety of users for applications relevant to LDCs. A detailed description of two village power systems is included. Energy cost comparisons are presented for PV systems versus alternative energy sources. It is concluded, based on present PV system technology, reliability and cost that photovoltaics provides a realistic energy option for LDCs in both the near- and far-term. (Author)

**A79-26163** On the diffusive instability of some simple steady magnetohydrodynamic flows. P. H. Roberts (Newcastle-upon-Tyne, University, Newcastle-upon-Tyne, England) and D. E. Loper (Florida State University, Tallahassee, Fla.). *Journal of Fluid Mechanics*, vol. 90, Feb. 27, 1979, p. 641-668. 30 refs. NSF Grant No. EAR-74-22249.

The paper investigates the stability characteristics of some simple steady magnetohydrodynamic flows within an axisymmetric container of arbitrary electrical conductivity, giving attention in particular to rapidly rotating fluids and a geomagnetohydrodynamic basic state representing a rigidly rotating homogeneous fluid with a uniform axial electric current. The stability of a fluid of finite electrical conductivity in a perfectly conducting axisymmetric container was analyzed, and a consistency condition was obtained, relating the change in frequency of a dissipationless eigenmode due to fluid resistivity to integrals of that eigenmode, and it was found that a class of modes (exceptional modes) exists which are destabilized by the introduction of Ohmic dissipation. This analysis was generalized to include finite conductivity of the walls. The effect of density gradients on the unstable modes was then investigated, and it was found that all fast modes and ordinary slow modes have standard stability properties in response to density gradients, but exceptional slow modes are stabilized by a top-heavy gradient and destabilized by a bottom-heavy gradient. P.T.H.

**A79-26176** Fluids engineering in advanced energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978. Meeting sponsored by the American Society of Mechanical Engineers. Edited by C. H. Marston (General Electric Co., Philadelphia, Pa.). New York, American Society of Mechanical Engineers, 1978. 250 p. Members, \$15.; nonmembers, \$30.

The papers presented deal with the fluid dynamical aspects of the design of advanced energy systems such as wind energy, MHD energy, wave system, and ocean thermal energy conversion. Topics discussed include a two-dimensional vortex sheet model of a Savonius rotor, control of wind power distribution in vortex augmentors, diffuser designs for improved wind energy conversion, the disk MHD generator, supersonic and subsonic diffusers for MHD applications, a high efficiency wave engine, modeling two phase flow in a swirl combustor, and working fluids and turbines for OTEC power systems. P.T.H.

**A79-26177 #** The interaction of the wind field with a horizontal axis wind turbine. R. H. Kirchhoff, K. Modarresi, and P. Murphy (Massachusetts, University, Amherst, Mass.). In: *Fluids engineering in advanced energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978.* New York, American Society of Mechanical Engineers, 1978, p. 1-13. 12 refs. U.S. Department of Energy Contract No. PF-67025-F.

A steady state, axisymmetric, potential flow model of the wind field upstream of a horizontal axis wind turbine is presented. The blade disk is modeled by a distribution of sources in its plane of rotation. An analytical expression for the potential function is developed. Sample flow field calculations for the UMass Solar Habitat I 25 kW wind turbine are presented. The dynamic interaction between the horizontal gustiness of the wind field and the instantaneous power generated by this 25 kW wind turbine is investigated by measuring the transfer function between wind speed and the generator voltage. (Author)

**A79-26178 #** A two dimensional vortex sheet model of a Savonius Rotor. E. S. Van Dusen and R. H. Kirchhoff (Massachusetts, University, Amherst, Mass.). In: *Fluids engineering in advanced energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978.* New York, American Society of Mechanical Engineers, 1978, p. 15-31. 15 refs.

A two-dimensional inviscid flow model is developed for a vertical axis windmill of the Savonius Rotor type with two foils of arbitrary shape. The solution is constructed by the superposition of streamfunctions for the uniform flows and the vortex sheets representing the foils and the wake vorticity. Calculations are performed in the reference frame of the rotating foils and include a time developing wake as vorticity is shed from the trailing edge of each foil. The results from different time steps, hence rotor orientations, are presented as plots of torque, streamlines, and power coefficient over a wide range of tip speed ratios. Results investigating the time step between solutions and different geometries are also presented and compared to empirical values. A heuristic stall model to account for flow separation is included in a manner that anticipates future viscous analysis. (Author)

**A79-26179 #** Vortex sheet analysis of the Giromill. R. E. Wilson (Oregon State University, Corvallis, Ore.). In: *Fluids engineering in advanced energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978.* New York, American Society of Mechanical Engineers, 1978, p. 33-43. 12 refs. Contract No. EY-76-S-06-2227. ERDA Task 23.

A two-dimensional analysis of the performance and flowfield of the Giromill is presented. The Giromill is a vertical-axis wind turbine with straight blades that are articulated to produce maximum energy extraction from the wind. It is found that the power coefficient and windwise force coefficient for the Giromill have the same limit as obtained for the horizontal-axis wind turbine. A cross-wind force is also obtained with this type of wind turbine. The cross-wind force is of second order and decreases with tip speed. Streamlines and velocity profiles are illustrated for several loading conditions. (Author)

**A79-26180 #** Wind power distribution, control, and conversion in vortex augmentors. P. M. Sforza and W. Stasi (New York, Polytechnic Institute, Farmingdale, N.Y.). In: *Fluids engineering in advanced energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978.* New York, American Society of Mechanical Engineers, 1978, p. 45-57. 7 refs. Contract No. E(49-18)-2358.

The Vortex Augmentor Concept (VAC) for fluid power conversion employs several basic aspects of fluid engineering: fluid power, fluid power control, and fluid machinery for power conversion. These features and their influence on design and development of an advanced wind energy conversion machine are discussed. The key concept is the generation and control of discrete vortical flows of high power density by appropriate interaction of aerodynamic surfaces with natural winds of relatively low power density, and then the use of suitably designed turbines to extract energy from the compacted vortical field. Generation of a power field in space is accomplished by the interaction of the fluid stream with an augmentor surface. Control of power level and distribution is

affected by configurational changes of the augmentor surface. Tests on various augmentor concepts are reported. P.T.H.

**A79-26181 #** Some flow analyses for Tornado-type wind turbines. C. T. Hsu (Iowa State University of Science and Technology, Ames, Iowa), G. L. Mellor (Princeton University, Princeton, N.J.), and J. T. Yen (Grumman Aerospace Corp., Research Dept., Bethpage, N.Y.). In: Fluids engineering in advanced energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978. New York, American Society of Mechanical Engineers, 1978, p. 59-71. 6 refs. Research supported by the Iowa State University of Science and Technology, U.S. Department of Energy, and New York State Energy Research and Development Authority.

The power coefficient of a Tornado-type wind turbine is analyzed for an incompressible and inviscid fluid with the assumption of radially equilibrium flow. A power coefficient based on the tower base area was chosen first. It is found that this coefficient mainly depends on the axial velocity allowed to be produced at the turbine outlet. A power coefficient based on the tower frontal area is computed next. It is found that our result is much more physically meaningful than that of Loth. Also, it is found that for the optimum value of the turbine outlet velocity, the ratio of the maximum power output of a Tornado-type wind turbine to the conventional wind turbine of the same size is proportional to the cube of the ratio of the tower to the turbine diameter. (Author)

**A79-26182 #** Diffuser designs for improved wind energy conversion. K. M. Foreman and B. L. Gilbert (Grumman Aerospace Corp., Bethpage, N.Y.). In: Fluids engineering in advanced energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978. New York, American Society of Mechanical Engineers, 1978, p. 73-91. 13 refs. Contract No. EY-76-C-2-2616.

The paper describes experimental work on two classes of compact diffusers for augmenting the power output of wind energy conversion systems. The first employs slot-injected air to energize the boundary layer of the internal flow, while the second employs short ring airfoils. The low pressure distribution along the internal ring surface of high-lift airfoil shapes induces augmented flow through the turbine if the latter is placed in a proper axial position. Results on baseline models and variants are presented in terms of an overall augmentation ratio and a dynamic pressure ratio. A baseline diffuser configuration combined with a nonoptimized turbine was shown to be able to produce almost 3.5 times the ideal power coefficient of a conventional wind turbine of same size. P.T.H.

**A79-26183 #** Two-dimensional MHD channel design. E. Doss, H. Geyer, Z. El-Derini, and R. K. Ahluwalia (Argonne National Laboratory, Argonne, Ill.). In: Fluids engineering in advanced energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978. New York, American Society of Mechanical Engineers, 1978, p. 93-109. 18 refs. Contract No. W-31-109-eng-38.

A two-dimensional MHD channel design model was developed for three modes of operation: the velocity, Mach number, and pressure modes. The MHD channel geometry can be predicted, given the distribution of any of these three parameters and the channel aspect ratio. The results for these modes are in excellent agreement with the results obtained with an original design where the area is specified. An arcing model is incorporated in the analysis, which allows MHD channels with cold walls to be rationally analyzed. Calculations indicate doubling of boundary layer voltage drop and 30% increase in wall heat flux as the wall temperature is reduced to 800 K from 1600 K; the two adverse effects combine to reduce channel output by 30%. A one-dimensional slag flow model is coupled to the two-dimensional flow model. The presence of the slag layer is shown to elevate the apparent wall temperature and thus improve channel performance, especially at lower wall temperatures. P.T.H.

**A79-26184 \* #** Velocity, temperature, and electrical conductivity profiles in hydrogen-oxygen MHD duct flows. M. S. Greywall (Wichita State University, Wichita, Kan.) and C. C. P. Pian (NASA, Lewis Research Center, Cleveland, Ohio). In: Fluids engineering in advanced energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978. New York, American Society of Mechanical Engineers, 1978, p. 111-120. 8 refs. Contract No. EF-77-A-01-2647; Grant No. NSG-3186.

This paper presents results of two-dimensional duct flow computations for radial distributions of velocity, temperature, and electrical conductivity. Calculations were carried out for the flow conditions representative of NASA Lewis hydrogen-oxygen combustion driven MHD duct. Results are presented for two sets of computations: (1) profiles of developing flow in a smooth duct, and (2) profiles of fully developed pipe flow with a specified streamwise shear stress distribution. The predicted temperature and electrical conductivity profiles for the developing flows compared well with available experimental data. (Author)

**A79-26185 #** Subsonic diffusers for MHD generators. T. R. Brogan (Meppco, Inc., Boston, Mass.), J. J. Idzorek (Fluidyne Engineering Corp., Minneapolis, Minn.), and D. Swallow (Maxwell Laboratories, Inc., Woburn, Mass.). In: Fluids engineering in advanced energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978. New York, American Society of Mechanical Engineers, 1978, p. 125-138. 10 refs. Research supported by the U.S. Department of Energy.

The paper discusses the interaction between the diffuser and MHD channel performance and reviews the state of the art regarding short subsonic diffusers with high inlet blockage. It has been found that conventional short, straight-wall, three-dimensional nonseparating diffusers will display a recovery coefficient of 0.45-0.50 in the MHD environment. This performance leaves much to be desired. With high inlet blockage, the performance of a nonseparating diffuser is comparable to that of a configuration operating with incipient separation. The diffuser exit flow pattern may cause a strong recirculation pattern to develop in the steam generator. This factor should be taken into account in the design of the radiant boiler. Vortex generators, contouring, and gas injection are potential methods for improving MHD diffuser performance, but any design must offer the compatibility of the diffuser configuration with the high velocity slag and seed-laden gas. P.T.H.

**A79-26186 #** On supersonic and subsonic diffusers for magnetohydrodynamic generator applications. G. D. Roy (Tennessee State University, Nashville, Tenn.). In: Fluids engineering in advanced energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978. New York, American Society of Mechanical Engineers, 1978, p. 139-152. 14 refs. Contract No. EX-76-C-01-1760.

Experimental investigations were made of both supersonic and subsonic diffusers with coal combustion gas (for MHD generator applications) with high entrance boundary layer blockage factors in the subsonic diffuser. It was found that a constant-area supersonic diffuser performed adequately. The pressure recovery is approximately 0.6 of the normal shock recovery with a diffuser length of approximately 70 percent of generator channel length. The subsonic diffusers have a maximum pressure recovery coefficient of 0.76 with an inlet blockage factor (B) of 0.16, which decreases to 0.6 at a higher blockage factor of 0.20, with 6 deg half angle. A quasi-one-dimensional analysis with friction, heat transfer and chemical reaction predicts well the pressure and heat-flux distribution in the channel, supersonic diffuser, and subsonic diffuser with small divergence angles. At large divergence angles, experimentally determined correction factors are applied. (Author)

**A79-26187 #** High efficiency wave engine. H. E. Weber (Pennsylvania State University, Radnor, Pa.). In: Fluids engineering in advanced energy systems; Proceedings of the Winter Annual

Meeting, San Francisco, Calif., December 10-15, 1978.

New York, American Society of Mechanical Engineers, 1978, p. 153-166. 10 refs.

A calculation method for determining the performance of a wave engine is outlined. It is applied to a wave engine with nozzles at the exit of the rotor blades and multiple reentries in the expansion portion of the cycle. Relatively high compression and expansion efficiencies are obtained after inclusion of the major losses in such a machine. Since each rotor blade passes through both hot and cold gas in each revolution, blade temperatures remain low for relatively high gas or combustion temperatures. This situation permits attainment of high cycle efficiencies. (Author)

**A79-26188 #** Flow modeling of an atmospheric pressure, entrained-type coal gasifier. J. D. Bianca, W. P. Pauver (Combustion Engineering, Inc., Windsor, Conn.), and J. G. McGowan (Massachusetts, University, Amherst, Mass.). In: Fluids engineering in advanced energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978. New York, American Society of Mechanical Engineers, 1978, p. 167-181. 14 refs.

This paper presents the results of a fluid mechanical study of an atmospheric pressure, entrained-type coal gasifier. A discussion of the criteria used for the flow modeling is given, resulting in the identification of the key gasifier design parameters that influence overall gasifier aerodynamics. The experimental flow modeling work, using both velocity and concentration measurements, is summarized and results are presented which led to modification of the original gasifier design. (Author)

**A79-26189 #** Modeling two-phase flow in a swirl combustor. A. K. Varma, W. S. Lewellen, and H. Segur (Aeronautical Research Associates of Princeton, Inc., Princeton, N.J.). In: Fluids engineering in advanced energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978. New York, American Society of Mechanical Engineers, 1978, p. 183-197. 11 refs.

A phenomenological model of flow in a cyclone coal combustor-gasifier has been developed. The principal purpose of the model was to provide guidance for the design and scaling of high pressure cyclone combustors. The model predicts how four performance parameters - carbon conversion efficiency, ash separation, pressure drop and heat transfer - depend on basic geometrical design variables and flow parameters of the system. Comparison of model predictions with some limited experimental measurements show reasonable agreement but further testing is necessary to determine the empirical parameters. Model derivation and sensitivity analysis identify the phenomena which have critical effects on the combustor performance. (Author)

**A79-26190 #** Modeling the champagne effect in compressed air energy storage. E. B. Smith, W. A. Blecher, and A. J. Giramonti (United Technologies Research Center, East Hartford, Conn.). In: Fluids engineering in advanced energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978. New York, American Society of Mechanical Engineers, 1978, p. 199-212. 11 refs.

Analyses were performed to determine the effectiveness of several modifications in the design of the hydraulic compensation system of a compressed air energy storage system in eliminating the possibility of blow out of the storage cavern. One alternative is to include a U-bend trap, and a previous analysis focused on determining the minimum depth of the U-bend needed to prevent blowout. This analysis is extended to determine the effect of flaring the shaft. A steady-state analysis of the full two-phase flow equations in the vertical shaft yields the pressure, velocity, and average density of the water-air mixture in the vertical shaft. Balancing the kinetic and potential energy then gives the added U-bend depth necessary to absorb the column inertia. Another analysis was performed to determine if oversizing the cavern could prevent cavern blowout. It

was found that blowout could be prevented by a U-bend with depth about 10% of the cavern depth. Use of a flared shaft does not significantly reduce the required depth. Oversizing the cavern by about 10% will also work. P.T.H.

**A79-26191 #** Performance of a hydraulic air compressor for use in Compressed Air Energy Storage power systems. J. A. Berghmans (Leuven, Katholieke Universiteit, Leuven, Heverlee, Belgium) and F. W. Ahrens (Argonne National Laboratory, Argonne, Ill.). In: Fluids engineering in advanced energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978. New York, American Society of Mechanical Engineers, 1978, p. 213-227. 7 refs. Research supported by the U.S. Department of Energy.

A fluid mechanical analysis of a hydraulic air compression system for Compressed Air Energy Storage (CAES) application is presented. With this compression concept, air is charged into an underground reservoir, for later use in power generation, by entraining bubbles into a downward flow of water from a surface reservoir. Upon releasing the air in the underground reservoir, the water is pumped back to the surface. The analytical model delineated in the paper is used to predict the hydraulic compressor performance characteristics (pumping power, pump head, compression efficiency) as a function of water flow rate and system geometrical parameters. The results indicate that, although large water pumps are needed, efficiencies as high as 90% (relative to ideal isothermal compression) can be expected. This should result in lower compression power than for conventional compressor systems, while eliminating the need for the usual intercoolers and aftercooler. (Author)

**A79-26192 #** Working fluids and turbines for OTEC power systems. D. D. Rosard (Westinghouse Electric Corp., Steam Turbine Div., Lester, Pa.). In: Fluids engineering in advanced energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978. New York, American Society of Mechanical Engineers, 1978, p. 229-246. 10 refs.

The paper discusses the thermodynamic and mechanical relations which affect the performance and size limitations of designs for the turbine of open-cycle ocean thermal energy conversion. Two key design parameters influencing turbine efficiency are the velocity ratio and the average gauging ratio (ratio of total flow area at throat of blades to total annulus area). It is shown that the optimum velocity ratio varies only slightly with gauging, and that higher values of gauging lead to lower efficiency as a result of higher axial exit velocity. The blade bending stresses are also taken into account in evaluating limiting performance. Parameters of an illustrative turbine design using the largest available disk (17 ft in diameter) are given. The combination of speed, diameter, and blade length are well within the limits of acceptable centrifugal stresses for a variety of blade materials including steel, titanium, aluminum, or fiberglass. P.T.H.

**A79-26201** Thermal storage and heat transfer in solar energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978. Meeting sponsored by the American Society of Mechanical Engineers. Edited by F. Kreith, R. Boehm (Utah, University, Salt Lake City, Utah), J. Mitchell (Wisconsin, University, Madison, Wis.), and R. Bannerot (Houston, University, Houston, Tex.). New York, American Society of Mechanical Engineers, 1978. 83 p. Members, \$5.00; nonmembers, \$10.00.

Papers are presented on air heating unglazed flat plate solar collectors, natural convection in inclined two-dimensional compound parabolic concentrators, and analysis of energy storage by phase change with an array of cylindrical tubes. Consideration is also given to earth-conducted heat losses from thermal storage systems, and to heat transfer and calorimetric studies of a direct contact-latent heat storage system. B.J.

**A79-26202 #** Analysis and design of air heating unglazed flat plate solar collectors. J. M. Alcone, A. B. Donaldson, and W. P.



Schimmel, Jr. (Sandia Laboratories, Albuquerque, N. Mex.). In: Thermal storage and heat transfer in solar energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978. New York, American Society of Mechanical Engineers, 1978, p. 1-6. 13 refs. Contract No. AT(29-1)-789.

A simplified analysis of unglazed flat plate air heating collectors is developed for use in conjunction with studies of systems involving these collectors. To develop the analysis, an energy balance is formulated for a generalized unglazed collector configuration and then solved via the Laplace transform technique. The analysis was verified by application to a collector configuration for which experimental results are available. Based on the verified analysis, preliminary design and optimization procedures are developed and illustrated by example. A discussion of the relative importance and interplay of the various parameters used to describe collector performance is developed via sensitivity analysis to aid in understanding the behavior of unglazed collectors. (Author)

**A79-26204 #** Heat transfer in a solar radiation absorbing fluid layer flowing over a substrate. Y. Kurosaki and R. Viskanta (Purdue University, West Lafayette, Ind.). In: Thermal storage and heat transfer in solar energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978. New York, American Society of Mechanical Engineers, 1978, p. 13-21. 16 refs.

A simple theoretical model has been developed to predict the temperature distribution in an irradiated liquid or liquid suspension flowing along an opaque substrate. The fluid is irradiated by focusing solar radiation on the layer. In the analysis the absorption and emission of radiation by the fluid and emission and reflection by the substrate are considered. A two-band (semitransparent and opaque) radiation model is employed to assess the feasibility of absorbing solar radiation directly in fluid and using the fluid layer-substrate system as a solar collector. The results obtained show that for given flow and thermal conditions there is an opacity of the fluid which yields an optimum thermal performance (e.g. collection efficiency) of such a system. The results also show that, all conditions and parameters being the same, a fluid in laminar flow will yield better performance than a fluid in turbulent flow. (Author)

**A79-26206 #** Natural convection heat transfer in small and moderate aspect ratio enclosures - An application to flat plate collectors. B. A. Meyer, M. M. El-Wakil, and J. W. Mitchell (Wisconsin, University, Madison, Wis.). In: Thermal storage and heat transfer in solar energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978. New York, American Society of Mechanical Engineers, 1978, p. 29-33. 16 refs. Contract No. E(11-1)-2941.

New York, American Society of Mechanical Engineers, 1978, p. 29-33. 16 refs. Contract No. E(11-1)-2941.

**A79-26207 #** Analysis of energy storage by phase change with an array of cylindrical tubes. N. Shamsundar (Houston, University, Houston, Tex.) and R. Srinivasan. In: Thermal storage and heat transfer in solar energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978. New York, American Society of Mechanical Engineers, 1978, p. 35-40. 11 refs. Contract No. EG-77-C-04-3974.

An analysis of two-dimensional phase change of a salt or other phase change material (PCM) is made for the tube array in a shell and tube heat exchanger. The tubes are cooled convectively inside by a flowing fluid. The variation of total heat flux with time is calculated for several combinations of design parameters, for in-line as well as staggered tube arrangements. This information is very useful in designing PCM heat exchangers for solar and other energy storage units. The results indicate that the one-dimensional formulae that are currently in use for design have large errors, and are unable to fully account for the effect of tube arrangements. The influence of

superheat in the liquid is studied, and a simplified method for ascertaining this influence is presented. (Author)

**A79-26208 #** Earth-conducted heat losses from thermal storage systems. L. U. Lilleht, J. T. Beard (Virginia, University, Charlottesville, Va.), and L. M. Fafarman. In: Thermal storage and heat transfer in solar energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978. New York, American Society of Mechanical Engineers, 1978, p. 41-44. 7 refs. Contract No. E(40-1)-5136.

In an effort to reduce the storage costs of solar thermal energy, it has been proposed to use the ground to provide some or all of the insulation of the storage medium and some of the thermal capacity as well. Analyses of heat losses from such systems are often quite difficult, especially for the more complicated geometries and due to their cyclical nature of operation. This paper presents a new method of estimating the steady-state heat conduction losses from storage systems in the shape of segments of spheres. The use of orthogonal toroidal coordinates is illustrated for predicting these losses from constant temperature objects imbedded in earth with another constant surface temperature. (Author)

**A79-26209 #** Sulfuric acid-water - Chemical heat pump/energy storage system demonstration. E. C. Clark (Rocket Research Co., Redmond, Wash.) and C. C. Hiller (Sandia Laboratories, Albuquerque, N. Mex.). In: Thermal storage and heat transfer in solar energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978. New York, American Society of Mechanical Engineers, 1978, p. 45-50. 5 refs. Research supported by the U.S. Department of Energy.

New York, American Society of Mechanical Engineers, 1978, p. 45-50. 5 refs. Research supported by the U.S. Department of Energy.

**A79-26210 #** Heat transfer and calorimetric studies of a direct contact-latent heat energy storage system. V. A. Costello, S. S. Melsheimer, and D. D. Edie (Clemson University, Clemson, S.C.). In: Thermal storage and heat transfer in solar energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978. New York, American Society of Mechanical Engineers, 1978, p. 51-60. 21 refs. Contract No. E(40-1)-5190.

A possible solar energy storage process is to store energy in the latent heat of fusion of salt hydrates with high heats of fusion and favorable melting points. The present study investigated the feasibility of a latent storage system with direct contact heat transfer. Three salt systems (calcium chloride, disodium hydrogen phosphate, and sodium sulfate) were studied as well as direct contact sensible heat storage in water. Volumetric heat transfer coefficients and thermal storage efficiencies were determined at various flow rates and column heights, and with varying numbers of diffusers. Good heat transfer rates and thermal storage efficiencies were obtained in the direct contact storage device. B.J.

**A79-26242** A better approach to the evaluation of the series resistance of solar cells. K. Rajkanan (McMaster University, Hamilton, Ontario, Canada) and J. Shewchun (Brown University, Providence, R.I.). *Solid-State Electronics*, vol. 22, Feb. 1979, p. 193-197. 23 refs. Research supported by the National Research Council of Canada; Contract No. E(04-3)-1203.

Series resistance is an important parameter in solar cell design and fabrication. Methods reported in literature for its determination are not suitable for routine use. This paper describes a simple method for obtaining the series resistance. Universal current-voltage characteristics of the solar cells are also given to illustrate the effects of series and shunt resistance. An explanation is offered for the often observed drop in efficiency when small area cells are scaled upward. Cells less than 0.25 sq cm represent the intrinsic potential of any given structure or diode but do not reflect series resistance effects that must be eliminated with larger area cells and the practical problems of gridding to allow for current collection. (Author)

**A79-26243** Diffusion length measurements in Schottky barrier GaAs solar cells. R. J. Lender, S. Tiwari, J. M. Borrego, and S. K. Ghandi (Rensselaer Polytechnic Institute, Troy, N.Y.). *Solid-*



*State Electronics*, vol. 22, Feb. 1979, p. 213, 214. 7 refs. Contract No. EG-77-S-01-4116.

**A79-26353 #** Radiation regime of inclined surfaces (Radiatsionnyi rezhim naklonnykh poverkhnostei). K. Ia. Kondrat'ev, Z. I. Pivovarova, and M. P. Fedorova. Leningrad, Gidrometeoizdat, 1978. 216 p. 140 refs. In Russian.

The work reviews the published literature on the solar radiation regimes of inclined surfaces of different orientation. Methods for computing direct, diffuse, reflected, and total solar radiation as well as radiation balance on vertical and inclined surfaces are presented for different climate zones of the globe. Tables listing the radiation characteristics of inclined and vertical surfaces are presented. The work is of use in the fields of agriculture and solar energy engineering. B.J.

**A79-26372 \*** Continuous extrusion of coal. C. England, R. Kushida, and C. Daksia (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). *Chemical Engineering Progress*, Aug. 1978, p. 92-94.

A feeding method for use with bituminous coals that exhibit plasticity at elevated temperatures is described and demonstrated on a small screw extruder previously used to extrude polyethylene. A metered feed of coal heated to a temperature just below that of incipient caking (approximately 450 C) is used. Modifications to the extruder consisting of ceramic band heaters, auxiliary cooling coils on the thrust bearing and special quick opening dies are detailed. Coals successfully extruded include high volatile A bituminous coals, high volatile B bituminous coals, a high volatile C bituminous coal and a coal with high ash content. The computer program, EXTRUD, used to simulate the extruder is described. Predicted power consumption exhibits 30% scatter, which is explained by the sensitivity of the coal friction coefficient to temperature profiles. Detailed analysis reveals some discrepancies in the program that need to be resolved. A.L.W.

**A79-26374 \*** Burn coal cleanly in a fluidized bed - The key is in the controls. J. A. Kobak (NASA, Lewis Research Center, Cleveland, Ohio). *Instruments and Control Systems*, Jan. 1979, p. 29-32.

The fluidized-bed combustion (FBC) process produces few sulfur emissions, and can burn wood, municipal solid waste as well as every kind of coal available in the U.S. The pressurized, coal-burning fluidized-bed reactor at NASA's Lewis Research Center is described, together with a discussion of the operating results. The FBC system at Lewis, having a completely instrumented reactor, is used to test turbine blade alloys for future power plant applications. With the same type of coal and limestone used in the first testing phase covering 136 hours, it was found that all NO<sub>x</sub> values were below the EPA standard of 0.7 lb/MBtu, whereas the maximum observed level of SO<sub>2</sub> was above the EPA standard of 1.3 lb/MBtu, but with the average SO<sub>2</sub> level, however, only 0.63 lb/MBtu. Unburned hydrocarbon and CO levels were very low, indicating combustion efficiencies of close to 99% in almost all tests. Testing is now underway using high temperature cyclones and gas turbine to eliminate erosion and corrosion effects which were observed after the initial tests on the turbine and blades. A.A.

**A79-26402** Energy development (Développement énergétique). M. Schneider-Maunory (Société Nationale Elf-Aquitaine, Paris, France). (*Congrès Mondial de Planification*, 7th, London, England, Sept. 25, 1978.) *Revue de l'Energie*, vol. 30, Jan. 1979, p. 9-16. In French.

Some possible solutions to the world energy problems are discussed including reduction in energy demand and the more efficient production and use of fossil fuels. The development of alternative energy sources is also briefly discussed. It is suggested that the world energy prospects are rather bright in the long term (about the year 2050) but rather bleak in the middle term (up to the year 2000). B.J.

**A79-26403** Energy policy of the European Economic Community (La politique énergétique de la Communauté Economique Européenne). J. Carrié. *Revue de l'Energie*, vol. 30, Jan. 1979, p. 17-23. In French.

A general overview of the energy policy of the EEC is presented without going into specific energy technologies. Subjects discussed include energy economics, the substitution of oil by other fuels, and international cooperation to assure continued energy imports. B.J.

**A79-26404** Fuels of the future. I (A propos des carburants du futur. I). M. Grenon. *Revue de l'Energie*, vol. 30, Jan. 1979, p. 32-37. In French.

General problems of energy demand are examined along with such possible solutions as synthetic fuels and primary sources of energy (hydroelectric, geothermal, nuclear and solar). Special consideration is given to the development of methanol- and hydrogen-based fuels. B.J.

**A79-26462** Wilson parameters for the system H<sub>2</sub>, N<sub>2</sub>, CO, CO<sub>2</sub>, CH<sub>4</sub>, H<sub>2</sub>S, CH<sub>3</sub>OH, and H<sub>2</sub>O. J. J. Davis and R. I. Kermode (Kentucky, University, Lexington, Ky.). *Fuel Processing Technology*, vol. 1, Oct. 1978, p. 247-259. 68 refs. NSF Grant No. AER-03259-A03.

Parameters for the Wilson equation have been determined for 24 of the 28 binary pairs in the system: H<sub>2</sub>, N<sub>2</sub>, CO, CO<sub>2</sub>, CH<sub>4</sub>, H<sub>2</sub>S, CH<sub>3</sub>OH, and H<sub>2</sub>O. The data for eleven pairs were fit using the symmetric convention, with the remaining pairs satisfying the unsymmetric convention. Coefficients for the missing pairs could be estimated from Henry's Law constants. References have been included for the heat capacities of liquid methanol and carbon dioxide. Heats of mixing were also found in the literature. This information, plus readily available gas heat capacities, provides sufficient information to calculate multi-component material and energy balances for the columns used in the separation of H<sub>2</sub>S and CO<sub>2</sub> by cold methanol absorption. (Author)

**A79-26463** Factors affecting bitumen recovery by the hot water process. J. G. Speight and S. E. Moschopedis (Alberta Research Council, Fuel Sciences Div., Edmonton, Canada). *Fuel Processing Technology*, vol. 1, Oct. 1978, p. 261-268. 10 refs.

The development of the Athabasca oil sands has become one of the major advances of the petroleum industry but the environmental impact of this gigantic processing scheme has been a cause of some concern. The present study investigates factors such as pH, cation types and surface active substances which may seriously affect the hot water process and the disposal of clays into the tailings pond. (Author)

**A79-26464** Mössbauer spectroscopy of iron in coal and coal hydrogenation products. B. Keisch (Carnegie-Mellon University, Pittsburgh, Pa.), G. A. Gibbon, and S. Akhtar (U.S. Department of Energy, Pittsburgh Energy Research Center, Pittsburgh, Pa.). *Fuel Processing Technology*, vol. 1, Oct. 1978, p. 269-278. 28 refs.

**A79-26465** Catalytic hydrodesulfurization and liquefaction of coal - Batch autoclave studies. J. Scinta and S. W. Weller (New York, State University, Buffalo, N.Y.). *Fuel Processing Technology*, vol. 1, Oct. 1978, p. 279-286. 13 refs. Research supported by Texaco and ERDA.

The hydrodesulfurization and liquefaction of a high sulfur West Virginia coal has been studied in batch autoclave experiments with tetralin and several Co-Mo-Al<sub>2</sub>O<sub>3</sub> catalysts. Monolith catalysts made from Corning monolith aluminas have been studied in three configurations. The most favorable liquefaction and desulfurization were obtained with a nominal configuration of 200 square cells/sq in. Four particulate catalysts made from controlled pore size aluminas were studied in two sets of experiments. Significant differences in the effects of pore size and stirring rate for sulfided and not-sulfided catalyst were observed. The most favorable distributions were obtained with a large pore, unsulfided catalyst at a low stirring rate and a small pore, sulfided catalyst at a high stirring rate. (Author)

**A79-26466** Coal gasification studies. I - Single stage complete gasification of coal using water as the hydrogen source. R. Butler and A. Snelson (IIT Research Institute, Chicago, Ill.). *Fuel Processing Technology*, vol. 1, Oct. 1978, p. 297-304. 11 refs. Research supported by the Consolidated Natural Gas Service Co.

The complete gasification of coal to low molecular weight hydrocarbons has been achieved in a single stage process using water as the source of hydrogen. Reaction times of one hour, and a temperature of 600 C were required. The reactions were carried out in a stainless steel reactor with iodine or FeI<sub>2</sub> as a catalyst. It is shown that FeI<sub>2</sub> is a catalyst for the reaction stainless steel + H<sub>2</sub>O yields H<sub>2</sub> + metal oxide and also for the coal hydrogenation reaction. The apparent excellent reduction efficiency is probably a consequence of the good contact between the coal sample and the catalyst, which at the reaction temperature has a significant vapor pressure. (Author)

**A79-26467** A mass and energy balance of a Wellman-Galusha gasifier. O. J. Hahn, D. P. Wesley, B. A. Swishelm, S. Maples (Kentucky, University, Lexington, Ky.), and J. Withrow (National Lime and Stone Co., Carey, Ohio). *Fuel Processing Technology*, vol. 2, Feb. 1979, p. 1-16. 11 refs.

A test was run on a commercial-size, moving-bed atmospheric gasifier to collect process data and to quantify trace gases with a coking bituminous coal (free swelling index /FSI/ 3 to 5). These data were desired to update and expand the available information used in the design of new gas producers and associated gas cleanup systems. The test runs were made with a sized 3.5 x 5 cm (1.5 x 2 inch) Eastern Kentucky Elkhorn No. 3 bituminous coal. As expected, the carbon utilization was high exceeding 99%, the heating value of the gas was 5.6 MJ/cu m; and the cold and hot gas efficiencies were 77% and 87%, respectively. The trace gases quantified were hydrogen sulfide (0.10%), ammonia (0.09%), and hydrogen cyanide (0.0052%). Cyclone dust was examined using a scanning electron microscope and found to be porous. (Author)

**A79-26468** Coal gasification studies. II - Reduction in the presence of I<sub>2</sub> with H<sub>2</sub>, and H<sub>2</sub>O/+ metal, at pressures up to 3500 p.s.i. and temperatures of 600 C in all quartz reactors. R. Butler and A. Snelson (IIT Research Institute, Chicago, Ill.). *Fuel Processing Technology*, vol. 2, Feb. 1979, p. 17-34. 22 refs. Research supported by the Consolidated Natural Gas Service Co.

**A79-26469** Bituminous coal extraction in terms of electron-donor and -acceptor interactions in the solvent/coal system. A. Marzec, M. Juzwa, K. Betlej, and M. Sobkowiak (Polish Academy of Sciences, Dept. of Petroleum and Coal Chemistry, Gliwice, Poland). *Fuel Processing Technology*, vol. 2, Feb. 1979, p. 35-44. 22 refs.

Experiments on high volatile bituminous coal extraction at ambient temperature have been carried out by means of 18 solvents having their electron-donor and -acceptor properties quantitatively determined (DN and AN numbers) by Gutmann's method. A model for coal extraction, based on the assumption that donor-acceptor bonds occur in coal and are responsible for binding together macromolecular networks and extractable substances filling the pores of a network, has been worked out and verified on the basis of experimental data. The results lead to the conclusion that extraction is, in principle, a substitution reaction: pore substances are replaced by a solvent molecule in their donor (network)-acceptor (pore substance) or donor (pore substance)-acceptor(network) bonds. Solvents capable of substitution are characterized by specific DN and AN values. (Author)

**A79-26470** Coke formation on hydrodesulfurization catalysts. M. Ternan, E. Furimsky, and B. I. Parsons (Department of Energy, Mines and Resources, Energy Research Laboratories, Ottawa, Canada). *Fuel Processing Technology*, vol. 2, Feb. 1979, p. 45-55. 16 refs.

The extent of coke formation was measured on a number of different hydrodesulfurization catalysts, primarily as a function of the catalyst chemical composition. Variations in the concentration of MoO<sub>3</sub> on the alumina, the type of catalyst promoter, the promoter/MoO<sub>3</sub> ratio, the presulfiding material and the reaction temperature were made. Increases in the reaction rate caused by either changes in the catalyst composition or by moderate changes in the reaction temperature were compared to the catalyst coke content. It was suggested that two types of coke were present on the catalyst, a reactive coke which is subsequently converted to reaction products and an unreactive coke which blocks catalytic sites. (Author)

**A79-26471** Cavity-type surfaces for solar collectors. F. Demichelis and G. Russo (Torino, Politecnico, Turin, Italy). *Applied Physics*, vol. 18, Mar. 1979, p. 307-309. 11 refs. Research supported by Fiat S.p.A.

The optical shape of the heater's surface of solar energy concentrating collectors is here examined. Multireflection effect, through a macrocavity analysis is introduced. The optical design of the cavity is accomplished and the cavity effect determined. Thermotechnical analysis of the system, in order to determine the optimal conditions for the heat transfer and for the maximization of the energy radiative balance, is introduced. (Author)

**A79-26523 #** Three-dimensional effects of electrode configuration on diagonal MHD generator performance. T. Hara and J. Umoto (Kyoto University, Kyoto, Japan). *Journal of Energy*, vol. 3, Jan.-Feb. 1979, p. 16-22. 12 refs. Research supported by the Kawakami Foundation.

The configuration effects of conducting sidewall (DCW) and insulating sidewall (ISW) on the performance characteristics of diagonal-type generators are studied analytically. Three-dimensional potential and current distributions in the channels of these two types are calculated by the finite method (FEM). It is shown that the number of mesh points can be reduced by the FEM in comparison with the finite-difference method in order to provide the same accuracy of the solutions. For cold-wall generators, the DCW channel is found to be superior to the ISW channel with respect to the electrical performances, and vice versa for hot-wall generators. A critical wall temperature, at which the power density vs wall temperature curves of these two types of generators intersect, is found to be dependent on the boundary-layer thickness, the pitch length, and the diagonal angle. (Author)

**A79-26524 #** Performance of a closed-cycle MHD generator with molecular impurities. M. Zlatanovic, A. Veefkind, and L. H. T. Rietjens (Eindhoven, Technische Hogeschool, Eindhoven, Netherlands). *Journal of Energy*, vol. 3, Jan.-Feb. 1979, p. 23-29. 14 refs.

The influence of small amounts of molecular impurities on the properties of a noble-gas alkali-seeded MHD plasma has been investigated theoretically and experimentally. The theory has been used to calculate the apparent electrical conductivity, the electron temperature, the electron number density, and the vibrational temperature in a stationary, homogeneous argon-cesium MHD plasma with addition of nitrogen. The agreement between theory and experiment was found to be reasonable. Two kinds of molecular impurities, N<sub>2</sub> and CO<sub>2</sub>, have been studied experimentally as the contaminants in a shock tube MHD generator. In two series of experiments, one at low and one at high stagnation temperature, the concentration of N<sub>2</sub> was varied over the range 0-2% and the concentration of CO<sub>2</sub> over the range 0-0.4%. In all cases the magnetic field was 3 T. The amounts of impurities which cause a reduction in electrical power output of about 30-40% were found to be the following: at low stagnation temperature, 2000-4000 ppm N<sub>2</sub> and 80-120 ppm CO<sub>2</sub>; at high stagnation temperature, 8000-9000 ppm N<sub>2</sub> and 700-1000 ppm CO<sub>2</sub>. The current distribution in the channel, the electron temperature, and number density as well as the apparent electrical conductivity were measured. (Author)

**A79-26538** Sampling and analysis of synthetic fuel processes. P. S. Dzierlenga, F. G. Mesich, and R. A. Magee (Radian Corp., McLean, Va.). *Environmental Science and Technology*, vol. 13, Mar. 1979, p. 288-293.

It is argued that sampling a synthetic fuel process and obtaining meaningful results is not a routine procedure and cannot be approached casually. The major requirements for a successful sampling effort are careful planning prior to the test effort, including the development of a good sampling plan and the use of an experienced, professional staff capable of efficiently executing the test plan and making in-field decisions to adjust to process changes and unanticipated problems. Planning prior to the test effort involves determining the scope of the sampling effort, analyzing the process to be sampled, selecting sampling and analytical procedures, and designating the program data evaluation requirements. B.J.

**A79-26595 \* #** Radiation energy conversion in space. K. W. Billman (NASA, Ames Research Center, Materials and Physical Sciences Branch, Moffett Field, Calif.). *Astronautics and Aeronautics*, vol. 17, Mar. 1979, p. 18-26.

Topics discussed at the third NASA conference on radiant energy conversion are reviewed. The unconcentrated-photovoltaic-generation version of a solar power satellite is described, noting that it will consist of a 21.3 x 5.3-sq-km silicon-solar-cell array expected to provide 17 Gw of electrical power, with 1 km in diam transmitters oriented to beam 2.45 GHz microwave power to two receiving/rectifying 'rectennas' on earth. The Solares space-energy-system concept, designed for providing a large fraction of the world's energy needs at costs comparable to those of future coal/nuclear alternative, is considered, as are subsystems for improving the economics of the solar power satellite. A concept proposing the use of relativistic-electron-storage rings for electron-beam energy transmission and storage, and a report on the production of a high temperature plasma with concentrated solar radiation are taken into account. Laser-conversion systems, including the direct-solar-pumped space laser, and the telec-powered spacecraft, are discussed. A.A.

**A79-26596 #** Power from space by laser. C. N. Bain. *Astronautics and Aeronautics*, vol. 17, Mar. 1979, p. 28-40. 73 refs.

High-powered lasers projected for application to a satellite power system are reviewed. The chemical laser, combining an oxidizer and fuel to produce a high-density chemical reaction, is considered, as is the gasdynamic type. The electric-discharge laser (EDL) in which a high-temperature, high-pressure gas is expanded through a supersonic nozzle, is described, noting that the most recent models use the fast-flow N<sub>2</sub>-CO<sub>2</sub> technique, with an electron beam controlling the discharge. Beam shaping is examined in relation to energy propagation, together with a discussion of the principal factors affecting the propagation of high-powered laser beams. Refractors/mirrors as well as adaptive optics for correcting errors resulting from vibration, flexure, and initial fabrication are taken into account. The relationship between power output and waste heat, the laser efficiency and costs, as well as mass-to-power ratios for various laser power transmission systems (LPTS) are analyzed. It is concluded that the development of an LPTS able to handle the satellite power appears technologically feasible using scaling and phased-array techniques. A.A.

**A79-26597 \* #** Laser aircraft. A. Hertzberg, K. Sun (Washington, University, Seattle, Wash.), and W. S. Jones (Lockheed Research Laboratories, Palo Alto, Calif.). *Astronautics and Aeronautics*, vol. 17, Mar. 1979, p. 41-49. 22 refs. Grant No. NGL-49-002-044.

The concept of a laser-powered aircraft is discussed. Laser flight would be completely compatible with existing airports and air-traffic control, with the airplane using kerosene only power, up to a cruising altitude of 9 km where the laser satellite would lock on and beam laser energy to it. Two major components make up the laser turbofan, a heat exchanger for converting laser radiation into thermal energy, and conventional turbomachinery. The laser power satellite would put out 42 Mw using a solar-powered thermal engine to

generate electrical power for the closed-cycle supersonic electric discharge CO laser, whose radiators, heat exchangers, supersonic diffuser, and ducting will amount to 85% of the total subsystem mass. Relay satellites will be used to intercept the beam from the laser satellite, correct outgoing beam aberrations, and direct the beam to the next target. A 300-airplane fleet with transcontinental range is projected to save enough kerosene to equal the energy content of the entire system, including power and relay satellites, in one year. A.A.

**A79-26599 #** Solar power satellites - The laser option. W. S. Jones and M. W. Hunter, II (Lockheed Research Laboratories, Palo Alto, Calif.). *Astronautics and Aeronautics*, vol. 17, Mar. 1979, p. 59, 67.

The option of using laser- instead of microwave beams in solar power systems is explored. The advantages of small transmitter aperture associated with lasers, whose wavelength is up to four times smaller than microwave, are considered, noting that the weight of the laser-transmitting aperture does not dominate the system. Possible damages arising from the use of microwaves and lasers in solar power systems are analyzed, concluding that lasers, in contrast to microwaves, affect only the surface of organisms, thus making assessment and control easier. A.A.

**A79-26623** Climatic change in connection with energy growth (Klimaänderung durch Energiewachstum). W. Bach (Münster, Universität, Münster, West Germany). *Brennstoff-Wärme-Kraft*, vol. 31, Feb. 1979, p. 49-56. 51 refs. In German.

Changes regarding the local and regional climate can be produced as a consequence of the technical and economical activities of man. It is probable that the continuing growth regarding the consumption of energy will also have an effect on the global climate. It is likely that such an effect will not be distinguishable from changes related to natural climatic fluctuations before the year 2000. It is, however, not advisable to wait until nature itself shows the effects produced as a consequence of the human activities, because these effects might be irreversible. In addition, time periods from at least 25 to 50 years are required for the occurrence of structural changes in the energy consumption pattern. It is, therefore, necessary to study the possible relations between human activities and the climate with the aid of models and scenario analyses. Approaches for doing this are discussed, taking into account various energy sources and energy strategies. G.R.

**A79-26624** The potential of fusion reactors as process heat source (Das Potential von Fusionsreaktoren als Prozesswärmequelle). H. Brockmann, H. Clermont, J. Darvas, S. Förster, H. F. Niessen, U. Ohlig, P. Quell, and B. Sack (Kernforschungsanlage Jülich GmbH, Institut für Reaktorentwicklung, Jülich, West Germany). *Brennstoff-Wärme-Kraft*, vol. 31, Feb. 1979, p. 61-66. In German.

It is illustrated with the aid of selected examples that fusion reactors can provide at the same time an energy source for electric power generation and a heat source for industrial chemical processes. The generation of superheated steam and the thermal decomposition of sulfuric acid are considered. The steam can either be used for the production of substitute natural gas from coal or for electric power generation with a high efficiency. The sulfuric-acid process in combination with an electrolysis procedure is employed for the production of hydrogen gas from water. Advantages of the considered approaches are related to the possibility to produce energy carriers which can be stored in addition to electrical power, for which the demand is subject to temporal fluctuations. G.R.

**A79-26723 #** Evaluation of the effectiveness of electric power systems for transport purposes (Otsenka effektivnosti oborudovaniia elektroenergeticheskikh sistem transportnykh sredstv). V. I. Krivtsev. *Akademiia Nauk SSSR, Izvestiia, Energetika i Transport*, Jan.-Feb. 1979, p. 123-132. 5 refs. In Russian.

An analytical method is proposed for determining correction

factors for evaluating the changes in the operational and economic indices that characterize the effectiveness of using electric power systems for transport purposes over limited periods of time. The expressions for the correction factors also can be used to determine some technological-economic indices. For illustration, the method is applied to a practical example. V.P.

**A79-26747** Diagnostics of Shiva Nova high-yield thermonuclear events. H. G. Ahlstrom, L. W. Coleman, F. Rienecker, Jr., and V. W. Slivinsky (California, University, Livermore, Calif.). *Optical Society of America, Journal*, vol. 68, Dec. 1978, p. 1731-1741. 28 refs. Contract No. W-7405-eng-48.

Experiments with the Shiva Nova laser facility which produce yield levels of scientific break-even and above will result in neutron, X-ray, and particle fluxes which will require specific attention to the survivability of diagnostic instrumentation. These yield levels will also allow the utilization of new diagnostics techniques which can provide detailed information on the state of the imploded fuel and pusher shells. (Author)

**A79-26815** Design considerations for residential solar heating and cooling systems utilizing evacuated tube solar collectors. D. S. Ward and J. C. Ward (Colorado State University, Fort Collins, Colo.). *Solar Energy*, vol. 22, no. 2, 1979, p. 113-118. 7 refs.

Evacuated tube solar collectors permit the use of a vacuum of sufficient magnitude to virtually eliminate convection and conduction heat transfer losses. These collectors generally require a minimum amount of material per sq m of collector and thus provide for the possibility of lower costs. The vacuum may help protect a selective surface used on the absorber against performance degradation over the life of the collector. Variations in the design of evacuated tube solar collectors are discussed. The design and performance of a solar heating/cooling system (liquid system) and of a cooling subsystem are outlined. An obvious conclusion is the advantages associated with the use of air as the collector fluid, with the result that freezing, boiling and corrosion difficulties occurring with liquid systems are eliminated. S.D.

**A79-26816** Efficient Fresnel lens for solar concentration. E. M. Kritchman, A. A. Friesem, and G. Yekutieli (Weizmann Institute of Science, Rehovot, Israel). *Solar Energy*, vol. 22, no. 2, 1979, p. 119-123. 13 refs.

The paper discusses a new design for a two-dimensional concave Fresnel lens which, while having grooves facing down to prevent 'blocking', is capable of maintaining high concentration even for large acceptance angles. The design resembles the 'ideal' concentrating mirrors reported by Winston (1970). The discussion is restricted to the two-dimensional case of linear concentrating elements where the sun is in the plane transverse to the linear axis. However, the treatment can be readily extended to circular elements. S.D.

**A79-26817** Performance of combined solar-heat pump systems. T. L. Freeman, J. W. Mitchell, and T. E. Audit (Wisconsin, University, Madison, Wis.). *Solar Energy*, vol. 22, no. 2, 1979, p. 125-135. 15 refs.

The study analyzes the thermal performance of three types of combined solar-heat pump systems: (1) a series system in which the solar storage is used as the source for the heat pump; (2) a parallel system in which ambient air is used as the source for the heat pump; and (3) a dual source system in which the solar storage or ambient air is used as the source, depending on which source yields the lowest work input. These combined systems are compared with conventional solar and heat-pump systems. The parallel combined system appears to be the most practical solar-heat pump system configuration over the heating season. Costs and the extent to which summer cooling is a requirement determine the relative merit of the parallel system, along with the conventional solar and heat-pump systems. S.D.

**A79-26818** Heat loss characteristics of an evacuated plate-in-tube collector. G. T. Roberts (Polytechnic of Wales, Pontypridd, Wales). *Solar Energy*, vol. 22, no. 2, 1979, p. 137-140.

A theoretical-experimental study is conducted to evaluate the heat loss from an absorber plate placed inside a partially evacuated glass tube. Experimental results are compared with those of a theoretical model of the system. The effect of introducing a gas of low thermal conductivity is assessed. A diagram is presented, showing the expected efficiency of a tube containing methyl iodide placed in an insulating block with cover reflection losses taken to be 16%, together with values of collector efficiency for other evacuated tube systems reported by McVeigh (1977). Advantageous characteristics, in addition to low heat loss, are mentioned. S.D.

**A79-26819** Design and optimisation of an absorption refrigeration system operated by solar energy. S. Alizadeh, F. Bahar, and F. Geoola (Arya Mehr University of Technology, Teheran, Iran). *Solar Energy*, vol. 22, no. 2, 1979, p. 149-154. 8 refs.

A general theoretical study on design and optimization of the water-lithium bromide and the ammonia-water absorption refrigeration cycles has been undertaken. The results of this study show that in general for fixed initial conditions and given system refrigeration capacity higher generator temperature causes higher cooling ratio with smaller heat exchange surfaces and consequently lower cost. A comparison of the two cycles also indicate that the water-lithium bromide system is simpler than the ammonia-water system and operates at a higher cooling ratio and smaller heat exchange surfaces for the same conditions. (Author)

**A79-26822** The effect of the dispersion of the characteristics of solar cells in large systems. A. Luque and E. Lorenzo (Escuela Técnica Superior de Ingenieros de Telecomunicación, Madrid, Spain). *Solar Energy*, vol. 22, no. 2, 1979, p. 187-189.

The random variation of the characteristics of a solar cell affects the maximum power obtainable from an array of cells. The study presents a theoretical model that relates the loss in array power to the mean value and standard deviation of the open-circuit voltage, short-circuit current and series resistance of individual cells. Both series- and parallel-connected arrays are considered. It is shown that the decrease in the efficiency of an array of solar cells is proportional to a function that represents the deviation between the mean and the minimum values of a normal variable. This function decreases with increasing number of array cells. Other formulas for array efficiency are also presented. S.D.

**A79-26823** Screening reversible reactions for thermochemical energy transfer. O. M. Williams and P. O. Carden (Australian National University, Canberra, Australia). *Solar Energy*, vol. 22, no. 2, 1979, p. 191-193. 5 refs.

Wentworth and Chen (1976) have introduced a convenient parameter, the turning temperature, for assessing the suitability of reversible chemical reactions for use in solar thermochemical energy transfer systems. The turning temperature is defined as the temperature at which neither reactant nor product formation is thermodynamically favored, and can be estimated to a good approximation from standard thermodynamic data alone. However, this approach applies only to systems operated at 1-atm pressure and is therefore unsuitable for assessing high-pressure reactions such as the ammonia dissociation/synthesis or the equivalent methanol reaction. The present note shows that the definition of the turning temperature may be modified to cover high-pressure reactions. An alternative characteristic temperature, the neutral equilibrium temperature, which defines more precisely the midpoint of a thermochemical energy transfer reaction is introduced. A discussion of the thermodynamic significance of the turning temperature shows that it serves as a useful guide to the thermodynamic limitations of proposed thermochemical energy transfer systems. S.D.

**A79-26947** The iron-titanium-hydrogen system: A transmission electron microscope (TEM) study. T. Schober (Kernfor-

schungsanlage Jülich GmbH, Institut für Festkörperforschung, Jülich, West Germany). *Scripta Metallurgica*, vol. 13, Feb. 1979, p. 107-112. 20 refs.

A transmission electron microscope (TEM) study of the hydrogenation of FeTi using high purity materials is presented. Hydrogen charging of the ingot samples was accomplished by using either one of these specially developed techniques: immersion of FeTi in dilute HCl (3.6%) at 60 C, or electrolytic charging of 3 mm ingot disks in very dilute H<sub>2</sub>SO<sub>4</sub> at 20 C and low currents. The two charging methods were found to circumvent the problems of oxidation and surface segregation and allow the study of FeTi-hydrides under highest purity conditions. It is shown that TEM techniques may be successfully applied to the study of hydrides useful for hydrogen storage. A.A.

**A79-26958 Contribution to the development of wind energy systems using static power electronic converters.** V. Rajagopalan and D. Veillette (Québec, Université, Trois-Rivières, Canada). In: PESC '78; Power Electronics Specialists Conference, Syracuse, N.Y., June 13-15, 1978, Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p. 69-75. Research supported by the Department of Energy, Mines and Resources, National Research Council of Canada, and Université du Québec.

A wind energy system, using a squirrel cage induction machine and a static power electronic conversion equipment, incorporating a novel and economical pulse frequency modulated three phase auxiliary impulse commutated inverter, is described. A complete description of the proposed power as well as control schemes is given, with special reference to its possible application in variable speed wind power conversion scheme. Experimental results obtained on a laboratory breadboard of the power electronic conversion equipment for a 2 KVA, 208 V, 60 Hz, 3 phase squirrel cage, inverter fed induction machine in self excited mode of operation with a 3 to 1 speed range, are reported. (Author)

**A79-26995 Low voltage behavior of lithium/metal dichalcogenide topochemical cells.** D. W. Murphy and J. N. Carides (Bell Telephone Laboratories, Inc., Murray Hill, N.J.). *Electrochemical Society, Journal*, vol. 126, Mar. 1979, p. 349-351. 10 refs.

**A79-26996 Discharge characteristics of a soluble iron-titanium battery system.** R. F. Savinell, C. C. Liu, R. T. Galasco, and S. H. Chiang (Pittsburgh, University, Pittsburgh, Pa.). *Electrochemical Society, Journal*, vol. 126, Mar. 1979, p. 357-360. 12 refs. Research supported by the Alcoa Foundation.

Constant-load and constant-current discharge data are presented for a soluble iron-titanium electrochemical system. Output performance is limited mainly by activation polarization in the anodic reaction,  $Ti(III) \rightarrow e(-)$  yields  $Ti(IV)$ . The influence of different electrode materials, including platinum, graphite foil, and titanium-base electrodes, and of temperature was investigated. (Author)

**A79-27207 Superbatteries - A progress report.** J. R. Birk (Electric Power Research Institute, Palo Alto, Calif.), K. Klunder, and J. C. Smith (U.S. Department of Energy, Washington, D.C.). *IEEE Spectrum*, vol. 16, Mar. 1979, p. 49-55.

Future batteries, known as superbatteries, expected to be used as replacements for scarce fuel sources in the utilities and transportation sectors, are discussed. The sodium-sulfur model is considered as an example, noting that while the lead-acid battery, as almost all conventional batteries, contains solid electrodes and a liquid electrolyte, the sodium-sulfur contains liquid electrodes and a solid electrolyte, which makes for longer life. Progress in designing inexpensive and well performing lead-acid batteries is taken into account, emphasizing the development of seals using bonding by thermal compression, and of high-quality beta-alumina electrolyte tubes. The performance of electric vehicles is noted, together with a description of the various requirements facing the battery designer, including cruise speed, acceleration, and engine life. Cost problems impeding the full-scale development and commercialization of superbatteries are mentioned. A.A.

**A79-27208 No ill winds for New Mexico utility.** T. W. Reddoch (Tennessee, University, Knoxville, Tenn.) and J. W. Klein (Oak Ridge National Laboratory, Oak Ridge, Tenn.). *IEEE Spectrum*, vol. 16, Mar. 1979, p. 57-61.

The NASA experimental 200 kW wind generator at Clayton, N.M., is discussed. A microprocessor as well as 256 bytes of RAM, 2 kbytes of EPROM, and related circuitry maintain synchronism and constant power output by handling start-up and shutdown control, alignment of the rotor assembly with wind direction, and protection against abnormal operating and environmental conditions. The system frequency has a characteristic natural mode of oscillation (Fourier component) at 3 Hz, with the wind-turbine frequency being the same, even though some recording noise does exist on the system frequency channel. The data from the first months of operation indicate that the experimental wind generator has performed superbly in an electrical environment having both significant variations in frequency (+ or - 0.5 Hz) and power swings on the output from conventional generation. A.A.

**A79-27213 Solar energy application of natural zeolites.** D. I. Tchernev (MIT, Lexington, Mass.). In: Natural zeolites: Occurrence, properties, use. Oxford, Pergamon Press, Ltd., 1978, p. 479-485. NSF-supported research.

The utilization of solar energy for cooling is usually achieved by means of sorption-refrigeration cycles. However, the conventional cycles using ammonia-water or lithium bromide-water solutions are inefficient because of the low solution temperatures obtainable with solar radiation and the high condenser temperatures required by air-cooled condensers. Zeolites provide a unique opportunity for a solid-gas adsorption cooling system because of their extremely nonlinear-adsorption isotherms. We have demonstrated the feasibility of using a zeolite system to provide domestic hot water and space heating with overall efficiencies above 75% and space cooling with an overall efficiency above 50%. The system uses natural chabazite or clinoptilolite as the solid adsorber and water vapor as the working fluid. The operation of the system is described and the experimental results are discussed. Preliminary estimates indicate that such a system will be economically competitive. (Author)

**A79-27219 Induction-generator/synchronous-condenser system for wind-turbine power.** B. T. Ooi and R. A. David (McGill University, Montreal, Canada). *Institution of Electrical Engineers, Proceedings*, vol. 126, Jan. 1979, p. 69-74. 18 refs. National Research Council of Canada Grant No. A-7784.

A novel wind-turbine-driven electric power system for isolated communities is described. The system components consist of an induction generator and a synchronous condenser. The synchronous condenser supplies the magnetisation current to the induction generator. Besides supplying the load power, the induction generator feeds the synchronous condenser with real power to replenish windage, friction and I<sup>2</sup>R losses to sustain it at synchronous speed. The theory of operation is given, and predictions based on it are experimentally verified. The controllers required to maintain regulated voltage and frequency in spite of load and wind velocity changes are investigated. Slip-energy recovery is involved, and preliminary test results are presented. (Author)

**A79-27302 # Calculation and design of liquid-metal MHD induction machines (Raschet i proektirovanie induktsionnykh MGD-mashin s zhidkometallicheskim rabochim telom).** G. A. Baranov, V. A. Glukhikh, and I. R. Kirillov. Moscow, Atomizdat, 1978. 248 p. 189 refs. In Russian.

Fundamental principles relating to the theory and design of liquid-metal MHD induction pumps and generators are discussed. Particular attention is given to the large body of experimental studies on electromagnetic and hydrodynamic processes in such machines. The construction of MHD machines with flat, helical and cylindrical channels is described. Optimal design considerations are presented. B.J.

**A79-27317** A proposed thermophotovoltaic solar energy conversion system. R. M. Swanson (Stanford University, Stanford, Calif.). *IEEE, Proceedings*, vol. 67, Mar. 1979, p. 446, 447. 11 refs. Research supported by the Stanford University and Electric Power Research Institute.

A solar-electric system is proposed and discussed. This system uses concentrated mirrors focusing on a thermophotovoltaic (TPV) converter. Within the TPV converter the concentrated sunlight heats a refractory radiator. A silicon photovoltaic cell faces the radiator, receives incandescent radiation from it, and converts this radiation into electricity. (Author)

**A79-27327** Wind energy. B. Wolff (American Wind Energy Association, Washington, D.C.) and H. Meyer (Windworks, Mukwonago, Wis.). Philadelphia, Pa., Franklin Institute Press, 1978. 82 p. 39 refs. \$6.50.

The 1972 Solar Energy Panel of NASA and the National Science Foundation estimated the potential wind power available in the U.S. to be about 100,000 gigawatts, which is 30 times greater than the projected energy consumption for 1980. Wind energy is discussed with a view of providing a practical foundation and guide to the analysis and application of wind energy conversion systems. The basic theory is set forth, considering drag and lift translators, power extraction, tip speed ratio and solidity, as well as optimum blade design. Wind energy conversion system components are examined, including the momentum exchange and the energy conversion devices, as well as control systems. Methods for estimating energy production are explored, together with a presentation of plots showing wind frequency distribution in arbitrary units, monthly wind variation, and daily wind variation. The wind energy system is discussed with emphasis on economic performance, indicating that the costs of such systems are less uncertain than those of other solar-electric technologies. Studies of wind energy applications are noted, as are environmental considerations. A.A.

**A79-27339 #** Controlled thermonuclear fusion (Upravliaemyi termoiadernyi sintez). E. P. Velikhov and B. B. Kadomtsev (Akademiia Nauk SSSR, Institut Atomnoi Energii, Moscow, USSR). In: Science and mankind: International annual. Moscow, Izdatel'stvo Znanie, 1978, p. 243-251. In Russian.

The paper reviews the elements of thermonuclear fusion and how scientists are currently at work on achieving controlled fusion to yield useful energy. The types of devices now being studied as possible means for achieving the proper temperatures and confinement times are briefly characterized. The concept of a hybrid reactor, in which a fusion reaction produces fast neutrons which are used to split uranium or thorium to produce an energy-yielding fission reaction, is briefly outlined. P.T.H.

**A79-27345** Run duration analysis of surface wind speeds for wind energy application. A. B. Sigl (South Dakota State University, Brookings, S. Dak.), R. B. Corotis (Northwestern University, Evanston, Ill.), and D. J. Won (Sargent and Lundy Engineers, Chicago, Ill.). *Journal of Applied Meteorology*, vol. 18, Feb. 1979, p. 156-166. 18 refs. Contract No. EY-76-S-06-2342.

Hourly wind speed records are used to develop a model for the probability distribution of wind speed persistence above and below fixed reference speeds. Examination of duration histograms from 19 sites for records varying from 5-24 years leads to the development of a simple composite distribution. Enforcement of smooth behavior and a parameter sensitivity analysis allow the model to be interpreted in terms of a single free parameter, which is then shown to be highly correlated to the seasonal mean wind speed at a site. Comparison of run duration results for 1 and 3 h data (the latter being the standard digitization presently used by the National Climatic Center) indicates a definite bias with the 3 h records. A correction scheme is derived to improve the 3 h results. (Author)

**A79-27372** Principles of solar engineering: F. Kreith (Solar Energy Research Institute, Golden; Colorado, University, Boulder, Colo.) and J. F. Kreider. Washington, D.C., Hemisphere Publishing Corp., 1978. 790 p. 332 refs. \$24.50.

The aim of the book is to present all the information necessary for the design and analysis of solar energy conversion systems. A combination of basic technical understanding and an appreciation of the economic aspects of using nonrenewable energy sources is developed. The divisions of the subject matter are as follows: introduction to solar energy and its conversion, fundamentals of solar radiation, fundamentals of fluid mechanics and heat transfer, methods of solar collection and thermal conversion, system analysis and economics of solar systems, solar heating systems, solar cooling and dehumidification, solar electric power and process heat, and a brief look at natural solar conversion systems such as wind energy, thermal ocean thermal gradient and wave power, and biomass conversion systems. P.T.H.

**A79-27375 \* #** Solar power satellite. H. P. Davis (NASA, Johnson Space Center, Houston, Tex.). *American Institute of Chemical Engineers, Annual Meeting, 71st, Miami Beach, Fla., Nov. 13, 1978, Paper*. 19 p. 35 refs.

The solar power satellite (SPS) concept, under evaluation by NASA since 1974, is discussed. A typical system providing a total of 10,000 MW of electrical power to the ground receiving stations is considered. Energy conversion systems, including the photovoltaic device category using single-crystal silicon cells, are taken into account, as are the 2.45-GHz microwave power-transmission link and the ground receiver (or rectenna). Concepts involving space construction of the satellite's large structures (5 x 25 km) are described, noting that a process similar to the familiar roll-forming of light sheet metal parts has been adapted to the space environment. Transportation vehicles are discussed, including the Space Shuttle planned to reach 60 flights per year by the mid 1980's. Electrical power forecasts and advanced systems cost projections are analyzed, together with a description of costs estimates. The indirect economics of energy research and development, and the present NASA/DOE SPS program are noted. A.A.

**A79-27376** Oceans '78: The ocean challenge; Proceedings of the Fourth Annual Combined Conference, Washington, D.C., September 6-8, 1978. Conference sponsored by the Marine Technology Society and Institute of Electrical and Electronics Engineers. Washington, D.C., Marine Technology Society; New York, Institute of Electrical and Electronics Engineers, Inc., 1978. 766 p. \$60.

Topics related to buoy technology are considered along with acoustic systems, ocean sciences, underwater work systems and procedures, economics and management of coastal regions, instrumentation, fisheries, unmanned underwater vehicles, law and policy, electromechanical cables/connectors and their components, acoustic sources and sonars, the large-scale development of ocean energy resources, remote sensing from satellites and aircraft, institutional aspects of ocean development, satellite radiometric and visible sensing, marine pollution analysis and monitoring, and navigation. Attention is also given to sea floor engineering, information and data systems, education and training for ocean involvement, novel devices for extracting energy from the ocean, deep-sea mining, wave direction measurement technology, and problems concerning the financing of ocean development. G.R.

**A79-27377** Environmental considerations for siting an ocean thermal conversion early ocean testing platform at four proposed areas. M. D. Sands (Interstate Electronics Corp., Anaheim, Calif.) and P. Wilde (California, University, Berkeley, Calif.). In: Oceans '78: The ocean challenge; Proceedings of the Fourth Annual Combined Conference, Washington, D.C., September 6-8, 1978. Washington, D.C., Marine Technology Society; New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p. 358-362. 14 refs. Contract No. EG-77-C-06-1033.

The OTEC concept uses the thermal gradient that naturally exists in the oceans to condense and evaporate a working fluid. OTEC-1 is not scheduled to have a turbine, or produce a net energy gain, but to demonstrate and evaluate various technological concepts. The site that is selected for OTEC-1 testing must be located within 200 nautical miles off the U.S. and its properties. The study sites designated for the considered investigation include Keahole Point, Hawaii; Punta Tuna, Puerto Rico; New Orleans, La.; and the West Coast of Florida. The main considerations for the assessment of potential environmental impacts are dependent upon the near field dispersion of the plume. Once isopleths are prepared for each contaminant introduced to the environment, applicable toxicity data for resident organisms can be compared. The environmental impacts that are under evaluation include the impacts that may result from trace element leaching from various components of the system. G.R.

**A79-27378 Technology considerations in the design of a commercial offshore energy conversion /OTEC/ plant.** W. W. Rogalski, Jr., R. J. Scott (Gibbs and Cox, Inc., Arlington, Va.), and J. G. Giannotti (Giannotti and Buck Associates, Inc., Riverdale, Md.). In: *Oceans '78: The ocean challenge; Proceedings of the Fourth Annual Combined Conference*, Washington, D.C., September 6-8, 1978. Washington, D.C., Marine Technology Society; New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p. 363-368. 5 refs.

The design and construction of an OTEC plant slated to produce electricity for commercial consumption in the near future presents a number of unique problems and is forcing the advancement of the state of the art in ocean structures in a number of fields. The successful deployment of a commercially viable OTEC plant is dependent upon identifying these technology areas and developing a program to insure that any potential program obstacles are adequately addressed. (Author)

**A79-27389 A wave activated electric generator.** T. Omholt (Maritime College, Bronx, N.Y.). In: *Oceans '78: The ocean challenge; Proceedings of the Fourth Annual Combined Conference*, Washington, D.C., September 6-8, 1978. Washington, D.C., Marine Technology Society; New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p. 585-589. 11 refs.

A large number of devices have been proposed for extracting energy from ocean surface waves. This paper proposes yet another which operates on the same principles as alternating current generators. The device forms a two-degree of freedom mechanical system producing power by electro-magnetic induction. The equations governing the system's motion, as well as, the rate of power generation is presented. These are solved in a special case, which for a typical set of operating conditions, lead to energy extraction from the waves of 35 percent. (Author)

**A79-27390 Energy from sea waves - System optimization by diffraction theory.** G. Sebastiani, M. Berta, and A. Blandino (Tecnomare S.p.A., Venice, Italy). In: *Oceans '78: The ocean challenge; Proceedings of the Fourth Annual Combined Conference*, Washington, D.C., September 6-8, 1978. Washington, D.C., Marine Technology Society; New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p. 590-595. 7 refs.

The paper deals with a computerized method for the determination of the optimal conditions for an efficient extraction of energy from sea waves. The analyzed system is a floating cylinder connected to an energy extracting device. The system has been studied parametrically, by calculating its maximum efficiency in function of the geometric dimensions and layout configuration. The diffraction theory has been used in order to calculate the hydrodynamic terms (forces, added masses, damping coefficients) taking into account the real interaction between the body and the sea. Moreover a true statistic of waves is used in order to compare the efficiency of various systems in real sea conditions. The results obtained have confirmed the possibility of optimizing the system efficiency with respect to the parameters examined. (Author)

**A79-27391 The use of ocean energy - A hydrostatic motor.** S. Selwyn and F. W. McCoy (Lamont-Doherty Geological Observatory, Palisades, N.Y.). In: *Oceans '78: The ocean challenge; Proceedings of the Fourth Annual Combined Conference*, Washington, D.C., September 6-8, 1978. Washington, D.C., Marine Technology Society; New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p. 599-601. NSF Grant No. OCE-76-18049; Contract No. N00014-75-C-0210.

A device which utilizes the hydrostatic gradient at sea is described. The apparatus is currently configured to drive a deep-sea sediment sampler but could be used for virtually any power requirement. A simplified schematic diagram is presented to illustrate the working principle, and sample calculations of the power available are provided. (Author)

**A79-27395 \* Hot corrosion of Ni-base turbine alloys in atmospheres in coal-conversion systems.** T. Huang, E. A. Gulbransen, and G. H. Meier (Pittsburgh, University, Pittsburgh, Pa.). *Journal of Metals*, vol. 31, Mar. 1979, p. 28-35. 28 refs. Contract No. E(49-18)-2484; Grant No. NSG-3214.

Alkali-metal contaminants in coal may form low-melting sulfate salts during coal gasification or subsequent combustion which can have very deleterious effects on turbine components. The mechanisms for the hot-corrosion phenomena are not completely understood. (Author)

**A79-27399 # Performance of a 5 MWt solar steam generator.** W. J. Oberjohn and W. T. Southards (Babcock and Wilcox Co., Alliance, Ohio). *American Society of Mechanical Engineers, Joint Power Generation Conference, Dallas, Tex., Sept. 10-14, 1978, Paper. 23 p.* Contract No. E(04-3)-1109.

A radiant heat test was conducted to verify the functional performance of a 5 MWt solar steam generator. The steam-generator modeled the essential features of a conceptual design proposed by the Honeywell team for the DOE 10 MWe Solar Pilot Plant. This paper describes the experimental steam generator and its instrumentation. Selected test results and analyses are presented which demonstrate that steam generator performance was predictable, controllable, and responsive. From this, it is concluded that fossil boiler technology can form the basis for a successful solar steam generator design. (Author)

**A79-27400 \* # The application of hydraulics in the 2,000 kW wind turbine generator.** S. Onufreiczuk (General Electric Co., Space Div., Valley Forge, Pa.). *National Conference on Fluid Power and Power Transmission, Philadelphia, Pa., Nov. 7, 1978, Paper. 16 p.* Contract No. NAS3-20058.

A 2000 kW turbine generator using hydraulic power in two of its control systems is being built under the management of NASA Lewis Research Center. The hydraulic systems providing the control torques and forces for the yaw and blade pitch control systems are discussed. The yaw-drive-system hydraulic supply provides the power for positioning the nacelle so that the rotary axis is kept in line with the direction of the prevailing wind, as well as pressure to the yaw and high speed shaft brakes. The pitch-change-mechanism hydraulic system provides the actuation to the pitch change mechanism and permits feathering of the blades during an emergency situation. It operates in conjunction with the overall windmill computer system, with the feather control permitting slewing control flow to pass from the servo valve to the actuators without restriction. A.A.

**A79-27529 Investigation of the thermophysical characteristics of cryogenic heat pipes with a metal-fiber wick.** M. G. Semen and A. I. Levterov (Kievskii Politeknicheskii Institut, Kiev, Ukrainian SSR). (*Inzhenerno-Fizicheskii Zhurnal*, vol. 35, July 1978, p. 48-53.) *Journal of Engineering Physics*, vol. 35, no. 1, Jan. 1979, p. 797-801. 11 refs. Translation.



The experiments described were carried out to study the thermophysical characteristics of liquid-hydrogen heat pipes with fibrous stainless steel and copper wicks. The temperature fields and critical heat fluxes are determined as a function of heat-transfer-agent excess and heat-pipe angle of inclination. The influence of the thermophysical properties of the working fluid and transport properties of the wicks on heat pipe performance is investigated. It is shown that heat pipes of this type exhibit excellent heat transfer characteristics. V.P.

**A79-27651** Applications of cryogenic technology. Volume 7 - Proceedings of the Conference on Cryogenic Energy Systems, Oak Brook, Ill., May 16-18, 1978. Conference sponsored by the Cryogenic Society of America. Edited by J. R. Missig (Liquid Carbonic Corp., Chicago, Ill.) and R. W. Vance (Cryogenic Society of America, West Rancho Palos Verdes, Calif.). Flushing, N.Y., Scholium International, Inc., 1978. 408 p. \$29.50.

Papers are presented on the implications of cryogenics for hydrogen energy, MHD power generation, and the application of superconducting technology to the energy field. Consideration is also given to military applications of superconductivity and to the application of cryogenic technology to controlled fusion. B.J.

**A79-27652** Hydrogen via gasification - Today and tomorrow. P. B. Tarman (Institute of Gas Technology, Chicago, Ill.). In: Applications of cryogenic technology. Volume 7 - Proceedings of the Conference on Cryogenic Energy Systems, Oak Brook, Ill., May 16-18, 1978. Flushing, N.Y., Scholium International, Inc., 1978, p. 22-36.

Both the commercially available and emerging technologies for producing hydrogen from coal are summarized. The commercially available technologies which are discussed are the Winkler process, the Koppers-Totzek process, the Lurgi process, and the Wellman-Galusha process. Of the emerging technologies, the Texaco process, the U-gas process and the steam-iron process are discussed, with emphasis on the latter. B.J.

**A79-27653** Progress in solid polymer electrolyte water electrolysis. L. J. Nuttall (General Electric Co., Wilmington, Mass.). In: Applications of cryogenic technology. Volume 7 - Proceedings of the Conference on Cryogenic Energy Systems, Oak Brook, Ill., May 16-18, 1978. Flushing, N.Y., Scholium International, Inc., 1978, p. 37-51.

The development of solid polymer electrolyte (SPE) technology for use in large-scale hydrogen production applications associated with energy storage and advanced energy systems is discussed. The principles of SPE technology are briefly reviewed and the current status of the SPE program is discussed in terms of reduced cost, improved efficiency, and cell scale-up. B.J.

**A79-27654** Hydrogen via thermochemistry and future water-splitting technologies. J. B. Pangborn (Institute of Gas Technology, Chicago, Ill.). In: Applications of cryogenic technology. Volume 7 - Proceedings of the Conference on Cryogenic Energy Systems, Oak Brook, Ill., May 16-18, 1978. Flushing, N.Y., Scholium International, Inc., 1978, p. 52-64. 17 refs.

Thermochemical water splitting technology is surveyed with reference to direct thermal splitting of water, thermochemical cycles, hybrid cycles, and the steam-iron process. In addition, other future-technology water-splitting processes are discussed including nuclear radiolysis techniques, biomass digestion, and photosynthetic and biochemical hydrogen production. B.J.

**A79-27655** An overview of the STOR hydrogen energy program. B. J. Berger (U.S. Department of Energy, Div. of Energy Storage Systems, Washington, D.C.) and W. R. Standley (TRW, Inc., Energy Systems Planning Div., McLean, Va.). In: Applications of cryogenic technology. Volume 7 - Proceedings of the Conference on Cryogenic Energy Systems, Oak Brook, Ill., May 16-18, 1978.

Flushing, N.Y., Scholium International, Inc., 1978, p. 72-86. 6 refs.

The nonfossil technologies being pursued by the Division of Energy Storage Systems (STOR) include water electrolysis, thermochemical water splitting, and a number of advanced concepts. The long-term objective of STOR is to develop technology to produce hydrogen from water at a cost of less than \$6 per million Btu. Consideration is also given to aspects of hydrogen storage, transmission, and utilization along with intra-DOE and international efforts in this field. B.J.

**A79-27656** Cryohydrogen-fuel for tomorrow's commercial aircraft. G. D. Brewer (Lockheed-California Co., Burbank, Calif.). In: Applications of cryogenic technology. Volume 7 - Proceedings of the Conference on Cryogenic Energy Systems, Oak Brook, Ill., May 16-18, 1978. Flushing, N.Y., Scholium International, Inc., 1978, p. 87-104. 6 refs.

Studies performed for NASA on the potential use of liquid hydrogen as an aircraft fuel are summarized. Particular consideration is given to a recently completed study on how utilization of LH<sub>2</sub> will affect the design of the engine and fuel system for a representative subsonic passenger transport. It is concluded that adoption of cryohydrogen as the fuel for future commercial aircraft will reduce the need for oil imports, reduce pollution, and provide lower cost and more energy-efficient transportation. B.J.

**A79-27657** Hydrogen - Potential key to tomorrow's energy utility. R. M. Lundberg (Commonwealth Edison Co., Chicago, Ill.). In: Applications of cryogenic technology. Volume 7 - Proceedings of the Conference on Cryogenic Energy Systems, Oak Brook, Ill., May 16-18, 1978. Flushing, N.Y., Scholium International, Inc., 1978, p. 105-110. 15 refs.

There are premium uses for fuels in the electric utility for which hydrogen seems appropriate. The cost of electrolytic conversion is marginal, but suitable for some utilities. The costs of storage may be the major obstacle to commercial scale development. There are adequate incentives and potentially a very large market to interest all utilities in the production of hydrogen for sale. Hardware for the large-scale combustion of hydrogen requires a moderate amount of development. Breaking into the field at a small scale, providing hydrogen for generator cooling and ignitor fuel, provides a flexible near-term strategy. The utilities have investigated many methods to supplant natural gas and recently have been looking at hydrogen as a fuel for such use either directly or by adding the hydrogen to the natural gas pipeline as a tradeoff. The fuel cell technology may become a superior option for peaking use by the gas-electric utility. G.R.

**A79-27659** Open-cycle MHD development. D. H. Bomkamp (Argonne National Laboratory, Argonne, Ill.). In: Applications of cryogenic technology. Volume 7 - Proceedings of the Conference on Cryogenic Energy Systems, Oak Brook, Ill., May 16-18, 1978. Flushing, N.Y., Scholium International, Inc., 1978, p. 135-144.

The purpose of the federally-funded Energy Conversion Alternatives Study was to identify alternative energy conversion concepts and to economically analyze these concepts. Ten types of advanced power plant concepts were analyzed in terms of overall energy efficiency from coal pile to bus bar and in terms of the cost of electricity. Of the concepts which were studied, open-cycle MHD (MHD topping cycle/steam bottoming plant) showed the highest overall system efficiency and had one of the lowest costs of electricity at 32 mills per kilowatt hour. A comparison between a steam and an MHD power plant is shown. The significant feature is that the large rotating machinery of a steam plant is replaced by an MHD generator. Since typical temperatures for MHD are higher, energy can be extracted more efficiently. G.R.

**A79-27660** An overview of liquid metal MHD. P. F. Dunn (Argonne National Laboratory, Argonne, Ill.). In: Applications of



cryogenic technology. Volume 7 - Proceedings of the Conference on Cryogenic Energy Systems, Oak Brook, Ill., May 16-18, 1978.

Flushing, N.Y., Scholium International, Inc., 1978, p. 145-158. Research sponsored by the U.S. Department of Energy and U.S. Navy.

Since high temperatures are not needed to provide adequate electrical conductivity, liquid-metal MHD (LMMHD) power generators operate in a relatively low temperature range (450-1600 K) and can be coupled to almost any heat source. The present paper describes the basic LMMHD cycle and gives details of other cycles, including LMFBR/LMMHD Rankine and open-cycle, coal-fired LMMHD. Efficiency comparisons are given for the various cycles and a schematic of a high-temperature Na-N<sub>2</sub> LMMHD facility is presented. B.J.

**A79-27661 #** Status of the U.S./U.S.S.R. cooperative program for the development of open-cycle MHD power generators. K. E. Tempelmeyer (Argonne National Laboratory, Argonne, Ill.). In: Applications of cryogenic technology. Volume 7 - Proceedings of the Conference on Cryogenic Energy Systems, Oak Brook, Ill., May 16-18, 1978. Flushing, N.Y., Scholium International, Inc., 1978, p. 159-172. Contract No. W-31-109-eng-38.

The cooperative program has been channeled into four major directions: (1) preparation of a joint status report on open-cycle MHD power generation; (2) joint materials tests in facilities in both countries; (3) joint tests in the Soviet U-25B facility with a U.S. superconducting magnet and a Soviet MHD generator; and (4) the design and testing of a large U.S.-built MHD generator to be tested in the U-25 facility. Working groups were organized in the U.S. to address the major problems in channel design and testing, electrode system development, and superconducting MHD magnetic development. Another working group was organized to prepare a status report covering all aspects of MHD. B.J.

**A79-27662** Superconducting magnet systems for MHD generator facilities. R. C. Niemann (Argonne National Laboratory, Argonne, Ill.). In: Applications of cryogenic technology. Volume 7 - Proceedings of the Conference on Cryogenic Energy Systems, Oak Brook, Ill., May 16-18, 1978. Flushing, N.Y., Scholium International, Inc., 1978, p. 173-194. 11 refs. Research supported by the U.S. Department of Energy.

The paper reviews superconducting magnet system design requirements and existing and planned superconducting magnet systems for MHD generators. It is concluded that the successful development and implementation of MHD systems for commercial power generation facilities is strongly dependent on the existence of reliable and economical large high-field superconducting magnet systems. The development of such magnet systems will require the utilization of a continuously advancing cryogenic technological base coupled with extensive contributions from various elements of the entire cryogenics industry. B.J.

**A79-27663** High energy physics superconducting magnets and cryogenic systems. C. H. Rode (Fermi National Accelerator Laboratory, Batavia, Ill.). In: Applications of cryogenic technology. Volume 7 - Proceedings of the Conference on Cryogenic Energy Systems, Oak Brook, Ill., May 16-18, 1978. Flushing, N.Y., Scholium International, Inc., 1978, p. 197-212. 6 refs.

A brief historical review of pool boiling systems is presented. This is followed by a description of three large superconducting magnet facilities: (1) ESCAR (Experimental Superconducting Accelerator Ring) at Lawrence Berkeley Laboratory, (2) ISABELLE (Intersecting Storage and Accelerator) at Brookhaven National Laboratory, and (3) TEVATRON (TeV Accelerator and Storage Ring) at Fermi National Accelerator Laboratory. B.J.

**A79-27666** Air Force applications of lightweight superconducting machinery. C. E. Oberly (USAF, Aero Propulsion

Laboratory, Wright-Patterson AFB, Ohio). In: Applications of cryogenic technology. Volume 7 - Proceedings of the Conference on Cryogenic Energy Systems, Oak Brook, Ill., May 16-18, 1978.

Flushing, N.Y., Scholium International, Inc., 1978, p. 293-334. 45 refs.

Consideration is given to the dominant factors which affect the development of such Air Force airborne superconducting machinery as alternators, MHD magnets, and energy storage devices. These factors include lightweight structure design and severe losses induced by transient fields and conductor motion. Adequate structure, stabilizing matrix and cooling are difficult to design because of weight and volume restrictions. The promise of greater thermal margin in advanced superconducting materials such as flexible multifilament Nb<sub>3</sub>Sn and the weight saving potential of advanced structural materials provides impetus for continued Air Force development programs. B.J.

**A79-27667** Doublet III. E. L. Hubbard (General Atomic Co., Fusion Div., San Diego, Calif.). In: Applications of cryogenic technology. Volume 7 - Proceedings of the Conference on Cryogenic Energy Systems, Oak Brook, Ill., May 16-18, 1978.

Flushing, N.Y., Scholium International, Inc., 1978, p. 337-353. 6 refs. Contract No. EY-76-C-03-0167.

An overview is presented of the Doublet III tokamak. Consideration is given to the doublet configuration, and to the construction, power systems, and test operation of the tokamak. The use of superconductors in future machines is briefly considered. B.J.

**A79-27668** The Alcator liquid nitrogen-cooled tokamaks. D. B. Montgomery and N. T. Pierce (MIT, Cambridge, Mass.). In: Applications of cryogenic technology. Volume 7 - Proceedings of the Conference on Cryogenic Energy Systems, Oak Brook, Ill., May 16-18, 1978. Flushing, N.Y., Scholium International, Inc., 1978, p. 354-366. 5 refs. Research sponsored by the U.S. Department of Energy.

Alcator A and C are discussed with reference to conductor selection, cool-down, recool, and the nitrogen cooling system. Both devices use large quantities of liquid nitrogen for precooled the magnetic field systems, reducing the ohmic power required by a factor of 4 to 7 depending on the temperature rise in the particular magnetic system. The Alcator A device, with a total weight of 9 tons, uses about 800 gallons of liquid nitrogen to cool down from room temperature; it has been cooled down 250 times. The Alcator C device, with a weight of 40 tons, is expected to use about 2400 gallons for cool-down and 60 gallons per pulse for recool. B.J.

**A79-27669** Status report on TFTR. P. J. Reardon (Princeton University, Princeton, N.J.). In: Applications of cryogenic technology. Volume 7 - Proceedings of the Conference on Cryogenic Energy Systems, Oak Brook, Ill., May 16-18, 1978.

Flushing, N.Y., Scholium International, Inc., 1978, p. 367-387.

The primary objectives of the Toroidal Fusion Test Reactor (TFTR) are the generation and confinement of 5-10 keV reactor-grade plasmas in a tokamak magnetic field configuration and the production of fusion energy on a pulsed basis. The TFTR will be used to study the physics of burning plasmas and the engineering aspects of a D-T burning tokamak operator with reactor-level plasma conditions. The present paper reviews the TFTR program with consideration given to primary functions, design requirements, and major engineering features. B.J.

**A79-27723** The Tritherm test house (Das Tritherm-Versuchshaus). D. Deutschmann (Robert Bosch GmbH, Zentralabteilung Bauten und Anlagen, Stuttgart, West Germany), A. Kehl, W. Kragl, and F. Scharf (Robert Bosch GmbH, Technisches Zentrum Forschung, Stuttgart, West Germany). *Bosch Technische Berichte*, vol. 6, no. 4, 1979, p. 195-208. 6 refs. In German.

The present paper deals with 'Tritherm' solar house designed by Junkers. The heating system of this test house uses solar radiation and the ambient atmosphere for space and water heating, partly

directly and partly indirectly by means of a heat pump. Peak loads are covered by a gas-fired supplementary heating system. Test results to-date indicate climate fuel consumption can be held as low as 10 percent of the initial consumption. The cost effectiveness of such installations, however, appear to be questionable. V.P.

**A79-27733** Toxic component concentration in kerosene-air mixture combustion products. V. N. Gruzdev. (*Aviatsionnaya Tekhnika*, vol. 21, no. 1, 1978, p. 49-52.) *Soviet Aeronautics*, vol. 21, no. 1, 1978, p. 36-38. Translation.

In the present paper, the contents of NO, NO<sub>2</sub>, and CO in the combustion products of kerosene-air mixtures are determined from thermodynamic calculations of combustion, involving the solution of a system of algebraic equations comprising a dissociation equation, the Dalton law, the balance of matter, and the conservation of heat content. The results are obtained for mixture temperatures ranging from 473 to 973 K and excess air ratios between 0.5 and 15.0. V.P.

**A79-27871** An investigation of dark current and photocurrent superposition in photovoltaic devices. N. G. Tarr and D. L. Pulfrey (British Columbia, University, Vancouver, Canada). *Solid-State Electronics*, vol. 22, Mar. 1979, p. 265-270. 8 refs. Research supported by the National Research Council of Canada.

The principle of superposition of light and dark currents states that the current flowing in an illuminated photovoltaic device subject to a bias V is given by the superposition of the short-circuit photo-current and the current that would flow at bias V in the dark. In this paper, a simple theoretical argument based on Shockley's (1949) analysis of the pn junction diode is presented to demonstrate that the superposition principle is valid for practical Si and GaAs homojunction photovoltaic devices subject to one sun illumination and biased close to the maximum power point. Computer simulation confirms that superposition can be a useful approximation even when recombination and photogeneration in the depletion region contribute significantly to the dark current and photocurrent, respectively. Computer simulation also shows that under one sun illumination and short-circuit conditions the quasi-Fermi levels in the depletion regions of typical Si and GaAs solar cells are shifted substantially from their equilibrium positions. S.D.

**A79-27876** Macroscopic stability and beta limit in the ELMO Bumpy Torus. D. B. Nelson and C. L. Hedrick (Oak Ridge National Laboratory, Oak Ridge, Tenn.). *Nuclear Fusion*, vol. 19, Mar. 1979, p. 283-292. 7 refs. Research sponsored by the U.S. Department of Energy.

Magnetohydrodynamic stability limits are determined for the ELMO Bumpy Torus. The relativistic hot-electron annuli are considered to be rigid, modifying the magnetic field but not interacting with the instability. A modified energy principle is used, and the stability problem is reduced to determination of the eigenvalues of an ordinary differential equation along each field line. A threshold hot-electron current is required for stability; its value agrees with experimental measurements. The calculations show that stable high-beta equilibria can be created. Experiments are being planned to test these predictions. (Author)

**A79-27877** Recombination-induced neutral-particle flux in tokamaks. Iu. N. Dnestrovskii, S. E. Lysenko (Akademiia Nauk SSSR, Institut Atomnoi Energii, Moscow, USSR), and A. I. Kisliakov (Akademiia Nauk SSSR, Fiziko-Tekhnicheskii Institut, Leningrad, USSR). *Nuclear Fusion*, vol. 19, Mar. 1979, p. 293-299. 14 refs. Translation.

On the Alcator device the main mechanism producing neutrals in the central region of the plasma at a density in excess of  $4 \times 10$  to the 14th per cu cm is recombination of protons and electrons. The calculated neutral fluxes and spectra agree with the measured values. A suitable method of determining the ion temperature from the tail of the fast-neutral spectra for a dense plasma is described. (Author)

**A79-27878** Pellet X-ray spectra for laser fusion reactor designs. G. R. Magelssen and G. A. Moses (Wisconsin, University, Madison, Wis.). *Nuclear Fusion*, vol. 19, Mar. 1979, p. 301-311. 9 refs. Research supported by the Electric Power Research Institute.

The calculated X-ray energy contents, spectra and pulse lengths for a range of simple target designs that include deuterium-tritium fuel surrounded by mercury are given. The calculations start with a compressed pellet core at the time of ignition and the evolution of the burning pellet is followed by using a plasma hydrodynamic-thermonuclear burn-radiative transfer computer code. It is shown that the pellet-released radiation energy contents, spectra and pulse lengths depend upon pellet mass, density and material structure, and total yield. (Author)

**A79-27879** Self-consistent analysis of alpha-particle heating of a fast-solenoid plasma. H. J. Willenberg (Washington, University, Seattle, Wash.). *Nuclear Fusion*, vol. 19, Mar. 1979, p. 313-326. 28 refs. NSF-ERDA-sponsored research.

A method is formulated to describe the development of the alpha particles produced by fusion in a slender cylindrical plasma column that includes a fusion source and nonuniform thermalization. A numerical technique is presented which makes it possible to determine in a fully self-consistent manner the alpha-particle and background-plasma behavior in the case where the alpha particles transfer energy to the plasma electrons and ions in a nonuniform manner during thermalization, and the plasma is heated and expands. This technique is applied to the particular case of a fast laser-heated solenoid plasma; a parametric study of alpha heating of plasmas with a variety of initial temperatures, radii, and plasma betas is also performed. It is shown that a plasma column with a radius of 7 mm, a temperature of 6 keV, and a beta value of 0.95 will attain an ion temperature of 10 keV (corresponding to a fusion energy gain of 8) after 3 ms and that a range of maximum gain occurs for initial temperatures of 5 to 7 keV. Consequences of anomalously high alpha-particle energy transfer and plasma transport coefficients are investigated. F.G.M.

**A79-27880** On the motion of runaway electrons in momentum space. G. Fussmann (EURATOM and Max-Planck-Institut für Plasmaphysik, Garching, West Germany). *Nuclear Fusion*, vol. 19, Mar. 1979, p. 327-334. 7 refs.

The suprathermal drag force and the motion of suprathermal electrons in momentum space are analyzed for a multi-component plasma. The calculations of the particle motion are based on the suprathermal Fokker-Planck equation and include relativistic effects. It is found that, owing to pitch angle scattering, the flow patterns in momentum space are more complicated than previously assumed. Simple expressions for the runaway threshold and the perpendicular momentum of relativistic runaways are derived. The acceleration and slowing-down of runaways are also briefly discussed. (Author)

**A79-27881** The effect of limiters and current profile on elliptic free-boundary MHD equilibria. C. L. Thomas and F. A. Haas (EURATOM and U.K. Atomic Energy Authority Fusion Association, Culham Laboratory, Abingdon, Oxon, England). *Nuclear Fusion*, vol. 19, Mar. 1979, p. 335-346. 12 refs.

The MHD equilibrium equations and assumptions of simple current profiles and various limiter configurations are used to investigate the ellipticity attainable in a straight magnetic quadrupole field. It is found that for certain prescriptions of parameters there are two values of ellipticity  $b/a$ . In practice, only the lower value is expected to be realizable; its maximum value depends on current profile and choice of limiter and, for the models used here, lies between 1.0 and 2.9. For the prescriptions that lead to a single ellipticity, the upper limit to  $b/a$  is set by the intervention of the separatrix, and for the present models a value of approximately 2.0 has been obtained. (Author)

**A79-27882** Stabilization of drift loss-cone instability /DCI/ by addition of cold ions. B. I. Kanaev (Akademiia Nauk SSSR, Institut Atomnoi Energii, Moscow, USSR). *Nuclear Fusion*, vol. 19, Mar. 1979, p. 347-359. 18 refs. Translation.

It is demonstrated experimentally that in the containment of a collisional hydrogen plasma in a PR-6 mirror trap, which is accompanied by strong instability, a quiescent phase occurs as a result of the inflow of cold plasma remaining after the injection is turned off. With the use of the technique of cutting off the inflow it has been shown clearly that the instability begins to develop when the inflow drops to a fairly low value. It is also shown that in earlier experiments on microwave stabilization of an instability the same inflow brought about the cold-ion filling of the potential well that was formed. By the use of the cut-off it became possible to create an empty well and to fill it with cold ions of a selected gas in a controlled manner. It was found that during filling of the well with hydrogen ions, suppression of the instability apparently takes place at values of cold-ion addition which are substantially lower than 5% of the hot-plasma density. A similar addition of argon ions has no stabilizing effect. (Author)

**A79-27884** Theory of dissipative drift instabilities in sheared magnetic fields. L. Chen, P. N. Guzdar, J. Y. Hsu, P. K. Kaw, C. Oberman, and R. White (Princeton University, Princeton, N.J.). *Nuclear Fusion*, vol. 19, Mar. 1979, p. 373-387. 25 refs. Contracts No. EY-76-C-02-3073; No. F44620-75-C-0037.

Several different techniques are used to study the stability of electrostatic drift-wave eigenmodes in a resistive plasma with finite magnetic shear. It is found that in the slab approximation, where usual shear damping is operative, resistivity contributes to an enhancement of this damping, and the enhancement factor increases with the electron-ion collision frequency. Thus, no unstable eigenmodes result. If the shear damping is nullified, either by introducing a strong spatial variation of the density gradient or by working in toroidal geometry with strong toroidal coupling effects, then unstable eigenmodes with growth rates increasing with electron-ion collision frequency are recovered. A perturbation calculation shows that the retention of electron-temperature fluctuations associated with the mode and the inclusion of temperature gradients do not alter these conclusions. Extensive numerical calculations are also presented. (Author)

**A79-27885** Characteristics of electron-cyclotron-resonance-heated tokamak power reactors. S. M. Wolfe, D. R. Cohn, R. J. Temkin, and K. Kreischer (MIT, Cambridge, Mass.). *Nuclear Fusion*, vol. 19, Mar. 1979, p. 389-399. 22 refs. NSF-supported research; Contract No. EG-77-S-02-4183.

The characteristics of electron-cyclotron resonance-heated tokamak reactors are determined, based on the requirements for wave propagation and absorption in the plasma. Heating at both the fundamental and the second harmonic is considered, and constraints on the toroidal beta and the minimum magnetic field required to obtain suitable fusion power densities are derived. The magnetic field and temperature necessary to achieve ignition are calculated on the basis of the empirical scaling law for energy confinement time. Frequency requirements are determined, and frequencies of the order of 200 GHz are shown to be attractive for heating tokamak reactors of moderate size and thermal power levels. It is concluded that the development of HF (at least 200 GHz) gyrotron sources will probably be necessary in order to use electron-cyclotron resonance heating in tokamak power reactors. F.G.M.

**A79-27886** The effect of thermo-electric forces on the density profiles in a thermonuclear plasma surrounded by a cold blanket. J. A. Markvoort (EURATOM and Stichting voor Fundamenteel Onderzoek der Materie, Instituut voor Plasma-Fysica, Jutphaas, Netherlands). *Nuclear Fusion*, vol. 19, Mar. 1979, p. 401-407. 23 refs. Research supported by the Nederlandse Organisatie voor Zuiver-Wetenschappelijk Onderzoek and EURATOM.

**A79-27887** Evidence for neutral-beam-injected oxygen impurities in 2XII-B. R. P. Drake and H. W. Moos (Johns Hopkins University, Baltimore, Md.). *Nuclear Fusion*, vol. 19, Mar. 1979, p. 407-410. 11 refs. Contracts No. EY-76-S-02-2711; No. W-7405-eng-48.

A series of experiments indicates that the principle source of impurities in the 2XII-B mirror confinement plasma experiment at Lawrence Livermore Laboratory is oxygen in the neutral beams. The dependence of O II 539 A emissions on neutral-beam current, spatial scans of oxygen emissions, impurity injection experiments, spectral scans of the O VI 1032 A line, and other experiments all support this conclusion. (Author)

**A79-27897** # Transport fuels from natural gas. B. V. Walker. *New Zealand Energy Journal*, vol. 51, Dec. 25, 1978, p. 194-196.

A solution to the energy problem with transport fuels in New Zealand is proposed through options based on natural gas. The advantages of natural gas are cited, noting that the technology for converting it for transport use is comparatively low in capital cost, high on reliability, and environmentally clean. A 15% methanol/gasoline blend is suggested for short-term options, and an examination of possible technical problems associated with the blend is presented, concluding that methanol/gasoline blends are good automotive fuels, and present no significant corrosion problems. Long-term options are analyzed, with methanol and synthetic gasoline as choices, showing that they are competitive and contrasting alternatives, methanol being economically more attractive, while synthetic gasoline displays no downstream problems. A.A.

**A79-27898** # Electricity - An indigenous transport fuel. D. J. Byers (Canterbury University, Christchurch, New Zealand). *New Zealand Energy Journal*, vol. 51, Dec. 25, 1978, p. 197-200. Research supported by the University of Canterbury, New Zealand University Grants Committee, and New Zealand Lottery Distribution Committee for Scientific Research.

The electric car, as a viable alternative to the gasoline-fuelled vehicle, is examined in the context of New Zealand's energy-consumption and transport-energy-requirements scenario. Estimates of oil and gasoline energy usage in transport for 1977 are considered, indicating that gasoline fuelled vehicles consume the most significant part of all of New Zealand's oil imports, thus making them the most vulnerable to challenge by the electric vehicle. A comparison of the operation of gasoline and battery-electric vehicles is made, based on official figures for 1977, and it is shown that a shift to electric vehicles could be made without overloading electricity generation capacity. Proposals for developing experimental electric cars, trucks, and other vehicles are considered, noting that the Electric and Hybrid Vehicle Act calls for the U.S. Government to fund up to 5000 advanced experimental vehicles for evaluation in 1981. Battery systems using aqueous acids, alkalines, or molten salt are considered and it is indicated that many battery types already seem to meet the requirements for various types of vehicles. A.A.

**A79-27899** Economic feasibility of solar water and space heating. R. H. Bezdek (U.S. Department of Energy, Washington, D.C.), A. S. Hirshberg, and W. H. Babcock (Booz, Allen, and Hamilton, Inc., Bethesda, Md.). *Science*, vol. 203, Mar. 23, 1979, p. 1214-1220. 12 refs.

The economic feasibility in 1977 and 1978 of solar water and combined water and space heating is analyzed for single-family detached residences and multifamily apartment buildings in four representative U.S. cities: Boston, Massachusetts; Washington, D.C.; Grand Junction, Colorado; and Los Angeles, California. Three economic decision criteria are utilized: payback period, years to recovery of down payment, and years to net positive cash flow. The cost competitiveness of the solar systems compared to heating systems based on electricity, fuel oil, and natural gas is then discussed for each city, and the impact of the federal tax credit for solar energy systems is assessed. It is found that even without federal incentives some solar water and space heating systems are competitive. Enactment of the solar tax credit, however, greatly enhances their competitiveness. The implications of these findings for government tax and energy pricing policies are discussed. (Author)

**A79-28028** Optical coatings for a space laser communications system. R. M. F. Linford (McDonnell Douglas Astronautics Co.,

St. Louis, Mo.) and E. A. Strouse (Perkin-Elmer Corp., Norwalk, Conn.). In: *Laser and fiber optics communications; Proceedings of the Seminar, San Diego, Calif., August 28, 29, 1978.*

Bellingham, Wash., Society of Photo-Optical Instrumentation Engineers, 1978, p. 55-66.

A study has been conducted to develop and evaluate the optical coatings required for a space laser communications system. The requirements for the Nd:YAG laser, solar collector optics, and other optical components are discussed. The approach to the design, fabrication, and evaluation of the coatings is outlined, including the environmental tests planned to determine the stability of the coatings in space. Selected experimental results are included. (Author)

**A79-28140** Optics applied to solar energy IV; Proceedings of the Seminar, San Diego, Calif., August 30, 31, 1978. Seminar sponsored by the Society of Photo-Optical Instrumentation Engineers. Edited by K. D. Masterson. Bellingham, Wash., Society of Photo-Optical Instrumentation Engineers (SPIE Proceedings. Volume 161), 1978. 122 p. \$36.

Papers deal with concentrating collectors, materials for solar photothermal converters, and measurements of insolation. Particular consideration is given to a comparison of solar thermal energy collection using fixed and tracking collectors, microstructural characterization of a black chrome solar selective absorber, and inclination dependence of pyranometer sensitivity. B.J.

**A79-28141** First-order design variables for concentrating solar collectors. J. F. Kreider (J. F. Kreider Associates, Boulder, Colo.). In: *Optics applied to solar energy IV; Proceedings of the Seminar, San Diego, Calif., August 30, 31, 1978.* Bellingham, Wash., Society of Photo-Optical Instrumentation Engineers, 1978, p. 2-11. 5 refs.

The three major design variables of solar concentrators - optical efficiency, heat loss coefficient, and heat removal factor - are described. Equations are presented for estimating these design variables; typical values are: optical efficiency in the range 50-70%, heat loss coefficient of 1-0.1 W/sq m deg C, and heat removal factors exceeding 0.95. B.J.

**A79-28142** System designs for low cost-low ratio solar concentrators. T. M. Knasel (Science Applications, Inc., McLean, Va.). In: *Optics applied to solar energy IV; Proceedings of the Seminar, San Diego, Calif., August 30, 31, 1978.* Bellingham, Wash., Society of Photo-Optical Instrumentation Engineers, 1978, p. 14-22. 6 refs.

Low-cost, low-ratio solar concentrators can be approached from a number of design principles. A fixed imaging system would have concentration highly dependent on the off-axis angle, and the moving solar image does not appear to be incompatible with the conditions. Nonimaging devices are available in low-cost, low-ratio design versions; the concentration is inversely proportional to the angular acceptance while the system length and diffuse acceptance are proportional to the angular acceptance. Booster systems can achieve up to a factor of 3 concentration on two-sided receivers with uniform illumination and appear to be relatively inexpensive. Light trapping techniques appear to satisfy all the design criteria and would be best employed with very costly receiver materials such as solar cells. B.J.

**A79-28143** Linear echelon refractor/reflector solar concentrators. D. F. Vanderwerf, R. H. Anderson, and R. H. Appeldorn (3M Co., St. Paul, Minn.). In: *Optics applied to solar energy IV; Proceedings of the Seminar, San Diego, Calif., August 30, 31, 1978.* Bellingham, Wash., Society of Photo-Optical Instrumentation Engineers, 1978, p. 23-28. 9 refs.

This paper describes some new configurations for linear incremental or Fresnel refractors and reflectors for solar energy concentration. The first system, a reflex type lens, uses crossed linear echelon elements and has convergence power in two dimensions. This refractor/reflector concentrates solar radiation to a spot focus. Large

area solar concentrators can be sectionally constructed to provide high power solar flux concentration. The second type of echelon reflector forms a linear focus of incident solar radiation. The reflector is selectively tilted with respect to incoming solar radiation, such that the design eliminates all riser step blockage of radiation at the reflecting echelons. This results in a higher efficiency concentrator than is achievable with a normally oriented linear focus concentrator. Design parameters and a ray trace analysis are presented for both concentrator systems. (Author)

**A79-28144** A flat plate multiple pass solar collector using aqueous optical properties. W. D. Antrim, Jr., M. J. Pitasi, and R. W. Miller (American Science and Engineering, Inc., Cambridge, Mass.). In: *Optics applied to solar energy IV; Proceedings of the Seminar, San Diego, Calif., August 30, 31, 1978.* Bellingham, Wash., Society of Photo-Optical Instrumentation Engineers, 1978, p. 29-35. 8 refs.

A flat plate multiple pass solar collector is described which bridges the gap between concentrators and conventional flat plate collectors. This novel collector performs optically by taking advantage of two fortuitous characteristics of plain water: high transparency to the optical spectrum and near total opacity to the infrared. As solar energy heats the water, the potential radiative escape of this energy is via the infrared. A simple multiple pass system impacts the solar energy sequentially as it is blocked by opacity of the water in the earlier passages. The design is such that it minimizes air convection losses by virtue of the layers of the multipass system. B.J.

**A79-28145** A parabolic solar reflector for accurate and economic producibility. W. D. Antrim, Jr., R. W. Miller, and M. J. Pitasi (American Science and Engineering, Inc., Cambridge, Mass.). In: *Optics applied to solar energy IV; Proceedings of the Seminar, San Diego, Calif., August 30, 31, 1978.* Bellingham, Wash., Society of Photo-Optical Instrumentation Engineers, 1978, p. 36-45. Contract No. EM-78-C-04-4275.

This paper focuses on the reflector portion of a solar collector, being developed for solar heating and cooling applications. Work to date on the second generation concentrating collector includes design and development of low-cost reflectors and breadboard testing of simplified tracking schemes. The concentrating parabolic reflector described herein is designed to maintain accurate geometry for good optical performance. This is accomplished by a construction which would also be low-cost in production quantities. The receiver is integral with the concentrating reflector and is functional in maintaining geometric tolerances; in addition, the receiver is designed for minimum heat loss and low cost. B.J.

**A79-28146** A comparison of solar thermal energy collection using fixed and tracking collectors. J. D. Garrison, G. T. Craig, and C. Morgan (San Diego State University, San Diego, Calif.). In: *Optics applied to solar energy IV; Proceedings of the Seminar, San Diego, Calif., August 30, 31, 1978.* Bellingham, Wash., Society of Photo-Optical Instrumentation Engineers, 1978, p. 46-54. 10 refs. Research supported by the San Diego State University.

Solar thermal energy collection at seven sites (Albuquerque, New Mexico; Ft. Hood, Texas; Hightett, Australia; Livermore, California; Maynard, Massachusetts; Raleigh, North Carolina; and San Diego, California) is calculated for air and vacuum flat plate collectors and a vacuum collector using cylindrical Winston collection. The hourly intensity and angular distribution of solar radiation is predicted for the calculations using insolation measurements and an insolation wheel. Tracking configurations include two-axis, vertical axis, polar axis, and east-west axis tracking. Fixed collector arrays are all tilted towards the equator at the latitude angle. These calculations indicate energy collection varies linearly with cloudiness index. B.J.

**A79-28147** Analysis of a Cassegrain solar furnace. M. H. Cobble, W. C. Hull, and R. A. Hays (New Mexico State University, Las Cruces, N. Mex.). In: *Optics applied to solar energy IV; Proceed-*

ings of the Seminar, San Diego, Calif., August 30, 31, 1978.

Bellingham, Wash., Society of Photo-Optical Instrumentation Engineers, 1978, p. 55-63.

A solar furnace consisting of a paraboloid of revolution which tracks the sun and reflects radiation to a hyperboloid of revolution having a common focus with the paraboloid is analyzed to determine the concentration available, using various eccentricities. The hyperboloid, in turn, reflects radiation to a focal plane placed at various distances from the vertex of the paraboloid. The ideal concentration is determined using the largest radius of all the rays from the sun falling on the paraboloid, this radius being the distance from the pierce point of the ray, in the focal plane, to the hyperboloid focal point. The concentrations can be augmented using a compound paraboloidal concentrator, and the ideal augmented concentration is developed for various combinations of eccentricity and vertex distances. The effect of scattering angles for the paraboloid and hyperboloid on the ideal concentration is shown separately and jointly.

(Author)

**A79-28148** Chemical vapor deposited molybdenum films for use in photothermal conversion. G. E. Carver, D. D. Allred, and B. O. Seraphin (Arizona, University, Tucson, Ariz.). In: Optics applied to solar energy IV; Proceedings of the Seminar, San Diego, Calif., August 30, 31, 1978.

Bellingham, Wash.,

Society of Photo-Optical Instrumentation Engineers, 1978, p. 66-71. 13 refs. Contracts No. ER-78-S-02-4899; No. EY-76-S-04-3709.

High IR reflectance combined with high solar absorptance is required for efficient photothermal conversion. Converters can be fabricated by depositing an absorber on a highly reflecting metal. The present paper shows that, unlike other deposition methods, chemical vapor deposition (CVD) can produce molybdenum films with an IR reflectance rivaling that of bulk molybdenum. Studies are being performed to determine how sensitively the reflectance reacts to inclusions of impurities into the molybdenum. Thin film passivators deposited on the molybdenum prevent reflectance losses induced by oxidation and ensure high-temperature survival of optimal reflectance. Complete converter stacks have been annealed at 550 C for over 1000 hours in air.

B.J.

**A79-28149** Chemical vapor deposited amorphous silicon for use in photothermal conversion. D. C. Booth, M. Janai, G. Weiser, D. D. Allred, and B. O. Seraphin (Arizona, University, Tucson, Ariz.). In: Optics applied to solar energy IV; Proceedings of the Seminar, San Diego, Calif., August 30, 31, 1978.

Bellingham, Wash., Society of Photo-Optical Instrumentation Engineers, 1978, p. 72-75. 7 refs. Contract No. ER-78-S-02-4899.

Efficient photothermal conversion requires surfaces of high solar absorptance and low thermal emittance. This can be accomplished by the tandem action of a good infrared reflector overlaid by a film of sufficient solar absorptance that is transparent in the infrared. Crystalline silicon is a suitable candidate for the absorber layer. Its indirect band gap, however, results in a shallow absorption edge that extends too far into the visible. In contrast, the absorption edge of amorphous silicon is steeper and located farther into the infrared, resulting in a larger solar absorptance. The paper reports on the fabrication of amorphous silicon absorbers by chemical vapor deposition (CVD). Their optical and structural properties are determined as a function of the deposition temperature. The effects of a progressive crystallization during anneal above 650 C are described and the performance of converter stacks that are identical 'twins' except for the use of a polycrystalline silicon absorber in one and an amorphous absorber in the other are reported.

(Author)

**A79-28150** Colored stainless steel - A new type of selective absorber. B. Karlsson (Arizona, University, Tucson, Ariz.) and C. G. Ribbing (Uppsala Universitet, Uppsala, Sweden). In: Optics applied to solar energy IV; Proceedings of the Seminar, San Diego, Calif., August 30, 31, 1978.

Bellingham, Wash.,

Society of Photo-Optical Instrumentation Engineers, 1978, p. 76-83. 10 refs. NSF Grant No. INT-76-02664.

Selective absorbers for solar photothermal conversion are required to have high absorptance or low reflectance over the spectral range of solar emission and low emittance or high reflectance in the IR region. The paper reports on reflectance measurements on a type 304 stainless steel which provides a reasonable approximation to the ideal selective surface. The desired selectivity was obtained by oxidation of the steel in an acid solution. The steel deteriorates at temperatures above 200 C; the deterioration mechanisms are dehydration and oxidation. It is suggested that the colored steel should be stabilized at higher temperatures by coating it with a thin film such as Cr<sub>2</sub>O<sub>3</sub>, SiO<sub>2</sub>, Al<sub>2</sub>O<sub>3</sub>, or Si<sub>3</sub>N<sub>4</sub>.

B.J.

**A79-28151** Microstructural characterization of a black chrome solar selective absorber. C. M. Lampert (California, University, Berkeley, Calif.). In: Optics applied to solar energy IV; Proceedings of the Seminar, San Diego, Calif., August 30, 31, 1978.

Bellingham, Wash., Society of Photo-Optical Instrumentation Engineers, 1978, p. 84-90. 10 refs. Research supported by the U.S. Department of Energy.

The microstructure and reflective properties of the CHROM-ONYX type of black chrome/metal selective absorber coating for solar collectors were investigated in order to gain an understanding of the effect of these factors on the mechanism of wavelength selectivity. Hemispherical reflectance measurements were carried out on seven samples. The coatings which exhibited the best sensitivity were 1.0-micron black chrome plated on copper and 0.7-micron black chrome on nickel-plated copper and steel. Electron microscopy showed that the black chrome consisted of a distribution of very fine chromium particles (in the 100-A range) suspended within a matrix of chromium oxide phase. This assembly was then agglomerated into larger particles within the 0.05-0.3 micron range; these larger particles formed a continuous network which constituted the coating.

B.J.

**A79-28152** New instrumentation for high temperature and hemispherical measurements of selective surfaces. M. R. Jacobson, R. D. Lamoreaux, R. P. Shimshock, N. Raouf, and B. O. Seraphin (Arizona, University, Tucson, Ariz.). In: Optics applied to solar energy IV; Proceedings of the Seminar, San Diego, Calif., August 30, 31, 1978.

Bellingham, Wash., Society of Photo-Optical Instrumentation Engineers, 1978, p. 92-97. 7 refs. Contracts No. ER-78-S-02-4899; No. EY-75-S-04-3709; No. F49620-77-C-0138.

The Measurement Laboratory at the University of Arizona's Sciences Center has been performing studies on the optical properties and durability of solar selective surface under simulated operating conditions. Recent developments include: (1) a transmission cell for the high temperature reflectometer is being designed to measure samples at high temperature (800 C) under vacuum or controlled atmospheres; (2) a new data processing system has been interfaced with the existing integrating sphere reflectometer; (3) a cylindrical vacuum emissometer for the measurement of the total hemispherical radiative power loss from a heated sample is under consideration; and (4) a Gaertner L119 ellipsometer is being extended into the near-IR to provide measurements of optical constants of absorber materials through the solar spectrum.

B.J.

**A79-28153** Specularity measurements for solar materials. M. A. Lind, J. S. Hartman, and H. L. Hampton (Battelle Pacific Northwest Laboratories, Richland, Wash.). In: Optics applied to solar energy IV; Proceedings of the Seminar, San Diego, Calif., August 30, 31, 1978.

Bellingham, Wash., Society of Photo-Optical Instrumentation Engineers, 1978, p. 98-105. 7 refs. Contract No. EY-76-C-06-1830.

A technique using Fourier transform analysis which is suitable for measuring the specularity of solar glass components in the mrad and sub-mrad is discussed and demonstrated. A brief mathematical background as well as illustrative examples are included. A number of methods for image analysis are discussed with particular emphasis given to electronic integrating detectors. Typical Fourier plane image distributions are given for a few common solar utilization materials

and details of the instrument used to produce the images are considered. The limitations and capabilities of various instruments are outlined along with methods for further enhancing the utility and sensitivity of the technique. (Author)

**A79-28154** Inclination dependence of pyranometer sensitivity. K. A. Reed (Argonne National Laboratory, Argonne, Ill.). In: Optics applied to solar energy IV; Proceedings of the Seminar, San Diego, Calif., August 30, 31, 1978. Bellingham, Wash., Society of Photo-Optical Instrumentation Engineers, 1978, p. 106-108. Contract No. W-31-109-eng-38.

The inclination dependence of Eppley Model 8-48 pyranometers (initially acquired to support solar collector testing) has been measured in indoor tests conducted at levels of illumination corresponding to about 500 and 1000 W/sq m. The sensitivity is found to decrease as the pyranometer is tilted from the horizontal, the magnitude of the decrease depending on the level of illumination as well as the angle of inclination. Potentially large residual errors may limit the usefulness of such data; until the residual is quantified, it is difficult to justify the use of Model 8-48 pyranometers. B.J.

**A79-28182** Development of specifications for recycled products. H. Alter (National Center for Resource Recovery, Inc., Washington, D.C.). (World Recycling Congress, 1st, Basel, Switzerland, Mar. 6-9, 1978.) *Conservation and Recycling*, vol. 2, no. 1, 1978, p. 71-84. 39 refs. U.S. Environmental Protection Agency Contract No. 68-03-2528.

The paper discusses certain aspects of the development of specifications for materials and fuels derived from the mechanical and/or chemical processing of mixed municipal wastes. Trends in the development of specifications for paper, steel, aluminum, glass, and refuse-derived fuels are studied, and tentative composition limits are presented. The status of various programs to develop tests to accompany specifications is discussed. P.T.H.

**A79-28183** Modern technology for recovering energy and materials from urban wastes - Its applicability in developing countries. M. A. Connor (Stellenbosch, University, Stellenbosch, Republic of South Africa). (World Recycling Congress, 1st, Basel, Switzerland, Mar. 6-9, 1978.) *Conservation and Recycling*, vol. 2, no. 1, 1978, p. 85-93. 27 refs.

Three developing countries, Kenya, India and South Africa, very different as far as population density, degree of urbanization, extent of industrialization and availability of domestic energy resources are concerned, were selected for particular study. For each of these countries the energy supply, use and distribution patterns, as well as current refuse disposal practices are described. The future use of various refuse treatment methods, particularly those involving energy recovery, in each of these countries is examined. The conclusions drawn for the above three countries are generalized and applied to developing countries as a group. It is concluded that the applicability of modern refuse treatment technology in such countries is limited. (Author)

**A79-28315** Theory of the striated corona in a theta pinch. N. A. Krall, J. B. McBride, and L. Matteson (Science Applications, Inc., La Jolla, Calif.). *Physics of Fluids*, vol. 22, Mar. 1979, p. 515-518. 7 refs. Research supported by the U.S. Department of Energy.

The radial striations observed in the low density corona surrounding a theta-pinch-confined plasma are explained as due to an instability at the ion plasma frequency driven by plasma rotation in the corona. A nonlocal theory is used to find radially extended modes, as observed experimentally. The observed wavelength of the striations can then be used to deduce the density in this region; this density is in reasonable agreement with estimates from numerical models. (Author)

**A79-28352** Solar thermal electrical power plants for Iran. S. Vojdani and V. J. Woollam (Arya Mehr University of Technology, Teheran, Iran). *Solar Energy*, vol. 22, no. 3, 1979, p. 205-210.

**A79-28353** A Markov model of solar energy space and hot water heating systems. G. F. Lameiro (Solar Energy Research Institute, Golden, Colo.) and W. S. Duff (Colorado State University, Fort Collins, Colo.). *Solar Energy*, vol. 22, no. 3, 1979, p. 211-219. 10 refs. Research supported by the Colorado State University and NSF.

This paper presents a Markov model approach to the generalized solar energy space heating performance analysis problem. Specifically, Markov chain models are developed to represent ambient temperature, insolation, hot water load and system performance. From the Markov transition probability matrices for these variables, long-term expected performance is calculated. The theoretical development is implemented in FORTRAN IV on a Control Data 6400 Computer System. Computational experience gained, using STOLAR 3.1 (STOchastic soLAR energy systems model), indicates the stochastic approach requires approximately five per cent of the time necessary for standard dynamic approaches with comparable performance results. The method also compared favorably with FCHART, a simplified design procedure. (Author)

**A79-28354** Thermal analysis of black liquid cylindrical parabolic collector. B. J. Huang, T. Y. Wung, and S. Nieh (National Taiwan University, Taipei, Nationalist China). *Solar Energy*, vol. 22, no. 3, 1979, p. 221-224.

In the present paper a simple theoretical analysis and an experiment are carried out for a modified concentrating collector which consists of a cylindrical parabolic reflector, a transparent glass tube centered along the focal line, and a highly absorbent black liquid which flows in the glass tube to directly absorb the concentrated solar beam radiation. The analytical results are presented in normalized form and proved to be in very good agreement with the experimental results. (Author)

**A79-28356** Results and analysis of a round robin test program for liquid-heating flat-plate solar collectors. E. R. Streed, J. E. Hill (National Bureau of Standards, National Engineering Laboratory, Washington, D.C.), W. C. Thomas, A. G. Dawson, III (Virginia Polytechnic Institute and State University, Blacksburg, Va.), and B. D. Wood (Arizona State University, Tempe, Ariz.). *Solar Energy*, vol. 22, no. 3, 1979, p. 235-249. 11 refs. Research supported by the U.S. Department of Energy and NBS.

**A79-28358** Solar absorption cooling feasibility. D. S. Ward (Colorado State University, Fort Collins, Colo.). *Solar Energy*, vol. 22, no. 3, 1979, p. 259-268. 39 refs. Research supported by the U.S. Department of Energy and Solar Energy Research Institute.

The thermodynamic efficiency of solar absorption cooling is very nearly equivalent to that of an electrically driven vapor-compression system with a high seasonal coefficient of performance (of the order of 2.0). In addition, water/lithium bromide absorption units have a history of demonstrated technical feasibility, particularly when integrated with a complete solar heating and cooling system. Economically, solar absorption cooling is marginal, but improves considerably with income tax incentives. B.J.

**A79-28359** A general design method for closed-loop solar energy systems. S. A. Klein and W. A. Beckman (Wisconsin, University, Madison, Wis.). *Solar Energy*, vol. 22, no. 3, 1979, p. 269-282. 20 refs. Contract No. E(11-1)-2588.

A general design method is presented for closed loop energy systems consisting of solar collectors, sensible energy storage and a closed-loop flow circuit in which thermal energy is supplied (through heat exchange) to a load above a specified minimum temperature. It is assumed that the energy supplied to the load is used at a constant thermal efficiency. Computer simulations were used to estimate the long-term thermal performance of these systems, and correlations between the system performance and the system design parameters, such as the collector characteristics, load size, climatic data, and the minimum useful temperature, are presented. (Author)

**A79-28360** Optical analysis of solar facility heliostats. E. A. Igel and R. L. Hughes (Sandia Laboratories, Albuquerque, N. Mex.). *Solar Energy*, vol. 22, no. 3, 1979, p. 283-295. 16 refs. Research supported by the U.S. Department of Energy.

Useful insights into significant operating parameters are gained by treating the mirror collector system of a central receiver solar power station as an optical system, no matter how large. A method has been developed for estimating the approximate size of the solar image cast by individual heliostats. As a consequence from the Coddington equations, a simple analysis of astigmatism has been developed. These predictive equations agree well with experiments performed with a spherical mirror over a range of angles of incidence exceeding 60 deg. Other than flat mirrors, several heliostat configurations were proposed and explored and were found amenable to the same analysis. All designs which attempt to superpose the reflected energy from several mirrors mounted and tracked together on the same frame are subject to the same simple rules. (Author)

**A79-28361** Direct solar transmittance for a clear sky. R. King and R. O. Buckius (Illinois, University, Urbana, Ill.). *Solar Energy*, vol. 22, no. 3, 1979, p. 297-301. 23 refs. Research supported by the University of Illinois.

An attempt is made to develop a general and simple model of direct solar transmittance in terms of fundamental measurable quantities. The spectral transmittance of the direct solar beam is formulated as a function of measurable quantities. Spectral integrations are performed with various combinations of the fundamental parameters. Approximate analytical forms are developed and unknown constants are determined from the spectral integration and expressed in terms of these fundamental parameters. B.J.

**A79-28366** Two-dimensional monochromatic X-ray imaging of laser-produced plasmas. D. B. van Hulsteyn, P. Lee, and K. B. Mitchell (California, University, Los Alamos, N. Mex.). *Optics Letters*, vol. 4, Apr. 1979, p. 126-128. 9 refs.

A slitted crystal spectrograph has been used to produce two-dimensional, spatially resolved, monochromatic images of laser-irradiated targets. The technique is described, and examples are presented for comparison with corresponding pinhole photographs. Resolution along and transverse to the dispersion are determined by the crystal rocking angle and geometry of the spectrograph, respectively. One important application of this technique would be to radiograph hot, compressed targets, since the slitted spectrograph behaves as a filtered rectangular pinhole. (Author)

**A79-28389** A model for coal fly ash filtration. R. Dennis and H. A. Klemm (GCA Corp., Technology Div., Bedford, Mass.). *Air Pollution Control Association, Journal*, vol. 29, Mar. 1979, p. 230-234. 13 refs. U.S. Environmental Protection Agency Contract No. 68-02-1438. EPA Task 5; EPA Task 6; EPA Task 7.

A new mathematical model for predicting the performance of woven glass filters with coal fly ash is described. The data base for this development includes an extensive bench and pilot scale study, field data from prior studies of fly ash filtration with glass fabrics, past studies of fabric filter cleaning mechanisms and a literature survey. Trial model applications with utility boilers operating at Sunbury, PA and Nucla, CO indicate excellent agreement between theory and practice for penetration and resistance characteristics. The introduction and experimental confirmation of two physical relationships were instrumental in model design. The first describes how dust dislodges from a fabric and its subsequent impact upon resistance and penetration in a multichambered system. The second concept relates to the large fraction of ash that passes through temporarily or permanently unblocked pores such that particle penetrations are essentially size independent. Additionally, the quantitation of the cleaning action and energy with dust removal method is included in the model. The calculation of dust specific resistance coefficient, based on size distribution parameters provides improved estimates of K<sub>2</sub> in lieu of its preferred direct measurement. (Author)

**A79-28390** Electrostatic precipitation tests with fuel oil ash. G. Dinelli, C. Borgatti (Ente Nazionale per l'Energia Elettrica, Pisa, Italy), and M. Rea (Padova, Università, Padua, Italy). *Air Pollution Control Association, Journal*, vol. 29, Mar. 1979, p. 242-248. 9 refs.

The main characteristics of the electrostatic collection of fuel oil ash has been investigated at a pilot precipitator installed in a laboratory rig. The relationship between collection efficiency, dust concentration and air velocity is studied and the influence of the spacing between the collection plates on both efficiency and effective migration velocity is discussed. Emphasis is put on the high degrees of efficiency attainable under suitable operating conditions. (Author)

**A79-28438** Lignite - Abundant raw material of the future (Le lignite - Matière première abondante d'avenir). P. Speich. *Revue de l'Energie*, vol. 30, Feb. 1979, p. 103-109. 9 refs. In French.

This is the last of a series of articles devoted to the use of lignite in the Federal Republic of Germany. It deals with research and development activities and a calendar of research and development projects. The biggest deposit of lignite, with reserves of 55 billion tons, is located in the Rhineland. The technical projects elaborated over the past decades call for the exploitation of the major part of this deposit, that is about 35 billion tons of lignite. The reserves correspondent to about the same energy reserves as all of Iran's oil deposits. It is one of the 'isolated energy' raw material deposits in the world. (Author)

**A79-28439** On future carburants. II (A propos des carburants du futur. II). M. Grenon. *Revue de l'Energie*, vol. 30, Feb. 1979, p. 118-124. In French.

As was noted in the first part of this article, there is widespread incertitude concerning both possible future conception levels and future fuel needs over the next few decades. Although research on substitute fuels is not being carried-out with great vigor, methanol, ethanol and hydrogen must be mentioned as being the most promising solutions, or at least the solutions which are being most actively studied. This article deals with these fuels of the 'future'. (Author)

**A79-28666 #** Study of photoelectric characteristics of photocells made from high-resistivity silicon (Issledovanie fotoelektricheskikh kharakteristik fotopreobrazovatelei iz kremniia s vysokim udel'nym soprotivleniem). N. M. Bordina, T. M. Golovner, G. M. Grigor'eva, K. N. Zviagina, L. B. Kreinin, and N. A. Milovanova (Vsesoiuznyi Nauchno-Issledovatel'skii Institut Istochnikov Toka, Moscow, USSR). *Geliotekhnika*, no. 6, 1978, p. 3-11. 7 refs. In Russian.

**A79-28667 #** Effect of form errors on the characteristics of ellipsoidal radiant energy concentrators (Vliianie pogreshnostei formy na kharakteristiki ellipsoidnykh kontsentratorov luchistoi energii). L. Ia. Paderin. *Geliotekhnika*, no. 6, 1978, p. 12-15. In Russian.

**A79-28668 #** Accelerated tests for coatings (K voprosu ob uskorennykh ispytaniakh pokrytii). R. A. Zakhidov (Akademiiia Nauk Uzbekskoi SSR, Tsentral'noe Proektno-Konstruktorskoe Biuro Nauchnogo Priborostroeniia, Uzbek SSR). *Geliotekhnika*, no. 6, 1978, p. 16-22. 11 refs. In Russian.

The application of an accelerated test method based on the so-called physical principle of reliability to accelerated life testing of the coatings for solar concentrators is considered. Considerable simplification of the method is achieved by assuming a linear form for the function relating the service life of the object to its operating regime. P.T.H.

**A79-28669 #** Controlling the radiant flux of a high-temperature solar energy conversion system over two parameters



(Regulirovanie luchistogo potoka vysokotemperaturnoi gelioustanovki po dvum parametram). V. V. Afian and A. V. Vartanian. *Geliotekhnika*, no. 6, 1978, p. 23-25. In Russian.

The principles of controlling a high-temperature solar installation with parabolic concentrator by means of simultaneous control over the power and density of the radiant flux at the center of the focal plane are developed. It is shown that by this method of power control there is practically no energy redistribution in a circle of radius equal to 0.001 times the ratio of the focal parameter of the parabola generator to the mirror precision measure. P.T.H.

**A79-28670 #** Production and application of rolling-welded aluminum alloy panels for solar water heaters for hot water and cooling systems (Proizvodstvo i primeneniye prokatnosvarnykh panelei iz aluminievyykh splavov dlia solnechnykh vodonagrevatelei sistem gorichyego vodosnabzheniya i okhlazhdeniya). N. I. Koriagin, Iu. M. Sigalov, Iu. N. Malevskii, and A. I. Malykhin (Gosudarstvennyi Nauchno-Issledovatel'skii Energeticheskii Institut, Moscow, USSR). *Geliotekhnika*, no. 6, 1978, p. 26-31. In Russian.

**A79-28671 #** Study of the temperature distribution across the width of the screen of low-temperature water heaters with tubular heat receivers (K issledovaniyu raspredeleniya temperatury po shirine ekrana nizkotemperaturnykh solnechnykh vodonagrevatelei s trubchatymi teplopriemnikami). G. Ia. Umarov, R. R. Avezov, and N. A. Kakharov (Akademiya Nauk Uzbekskoi SSR, Fiziko-Tekhnicheskii Institut, Tashkent, Uzbek SSR). *Geliotekhnika*, no. 6, 1978, p. 41-46. 7 refs. In Russian.

**A79-28672 #** Study of the spectral characteristics of metalized polymer films for production of solar concentrators (Issledovanie spektral'nykh kharakteristik metallizirovannykh polimernykh plenok dlia izgotovleniya solnechnykh kontsentratorov). A. Iazkulyev, A. A. Trofimova, N. S. Galkina, and M. Kholeva (Akademiya Nauk Turkmen'skoi SSR, Fiziko-Tekhnicheskii Institut, Ashkhabad, Turkmen SSR). *Geliotekhnika*, no. 6, 1978, p. 53, 54. 5 refs. In Russian.

**A79-28901 \*** Nuclear Science Symposium, 25th, and Symposium on Nuclear Power Systems, 10th, Washington, D.C., October 18-20, 1978, Proceedings. Symposia sponsored by IEEE, DOE, NASA, and NBS. *IEEE Transactions on Nuclear Science*, vol. NS-26, Feb. 1979, pt. 1, 984 p.

Detectors of various types are discussed, taking into account drift chambers, calorimetry, multiwire proportional chambers, signal processing, the use of semiconductors, and photo/optical applications. Circuits are considered along with instrumentation for space, nuclear medicine instrumentation, data acquisition and systems, environmental instrumentation, reactor instrumentation, and nuclear power systems. Attention is given to a new approach to high accuracy gaseous detectors, the current status of electron mobility and free-ion yield in high mobility liquids, a digital drift chamber digitizer system, the stability of oxides in high purity germanium, the quadrant photomultiplier, and the theory of imaging with a very limited number of projections. G.R.

**A79-28917** 200-kv Blumlein transmission line for ultrafast toroidal theta-pinch. H. Nihei, J. Morikawa, K. Yamazaki, N. Inoue, and T. Uchida (Tokyo, University, Tokyo, Japan). *Electrical Engineering in Japan*, vol. 97, Nov.-Dec. 1977, p. 8-16. 9 refs. Translation.

Blumlein lines are proposed for tokamak plasma heating based on the fact that the Blumlein line (BL) makes it possible to generate a high-speed magnetic pulse very efficiently. Attention is directed to a detailed discussion of the characteristics of the BL and the electromagnetic fields generated by it. The energy transfer efficiency from the BL to the shell (or toroidal one-turn coil) is analyzed theoretically. Equations are derived which can be used for optimization of circuit constants of BL and switches, maximization of energy

transfer efficiency, and analysis of macroscopic mutual interaction between ultrahigh-speed magnetic pulse and plasma. Experimental evidence on the release of hydrogen atoms indicates that the plasma is heated by the magnetic field. S.D.

**A79-28922** Optimum power plant capacity of ocean-based ocean thermal energy conversion systems. T. Kajikawa, T. Agawa, and T. Homma (Ministry of International Trade and Industry, Electrotechnical Laboratory, Tokyo, Japan). *Electrical Engineering in Japan*, vol. 97, Nov.-Dec. 1977, p. 74-81. 11 refs. Translation.

A procedure is proposed to optimize the ocean thermal energy conversion plant capacity on the basis of performance evaluation by the heat transfer area of heat exchanger per net generated output power. This optimization process is illustrated by the example of a plant with total output capacity of 100 MW (working fluid NH<sub>3</sub>). Temperature and pump power allocations and the required dimensions of the optimal plant are derived. Pump powers required for intake of warm and cold water are expressed in terms of water velocity and friction factor. The plant capacity is varied from 1000 MW to 1 MW, and the effects of various factors on plant capacity and generation cost are analyzed. The evaluation function is strongly dependent on the temperature of warm water. S.D.

**A79-28924** Operational characteristics of MHD turbine with air-core superconducting rotor. T. Karasaki and M. Katsurai (Tokyo, University, Tokyo, Japan). *Electrical Engineering in Japan*, vol. 97, Nov.-Dec. 1977, p. 112-119. 10 refs. Translation.

The operational characteristics of an MHD turbine with air-core superconducting magnet are analyzed, with particular attention to the effectiveness of the superconducting rotor for Rm greater than unity. For this purpose, the effect of the permeability of rotor material is studied using a linear flow model, and the operational characteristics of the MHD turbine with the air-core superconducting rotor are compared with those of an MHD turbine with iron-core superconducting rotor. Only axial flow type machines are considered. It is shown that the output power density of the MHD turbine with the air-core rotor does not decrease even when the Rm-number is high but increases in proportion to it. Advantages of the air-core rotor machine are established. S.D.

**A79-28983** Feasible operating regions for moving bed coal gasification reactors. H. Yoon, J. Wei, and M. M. Denn (Delaware, University, Newark, Del.). *I & EC - Industrial and Engineering Chemistry, Process Design and Development*, vol. 18, Apr. 1979, p. 306-312. 19 refs. Research supported by the Electric Power Research Institute.

Feasible operating regions for moving bed coal gasification reactors are defined on a triangular diagram of carbon, oxygen, and steam feed ratios. Operability is limited by stoichiometry, thermodynamic equilibrium, and kinetics and physical rate processes. (Author)

**A79-28984** A regenerative process for fluidized-bed combustion of coal with lime additives. R. T. Yang and M.-S. Shen (Brookhaven National Laboratory, Upton, N.Y.). *I & EC - Industrial and Engineering Chemistry, Process Design and Development*, vol. 18, Apr. 1979, p. 312-316. 11 refs.

A regenerative process for fluidized-bed combustion of coal with lime additives has been investigated. This process is based on using carbon for lime regeneration from the sulfated limestone. Ten sulfation/regeneration cycles using Greer limestone have been conducted in a TG system and there was no sign of weakening of the SO<sub>2</sub> sorption activity. Kinetic and mechanistic studies on the regeneration reaction have also been performed, which included the effects of temperature, water vapor, particle size, and catalysts such as sodium chloride. (Author)

**A79-28988** Cogeneration in Europe and the combined cycle gas turbine. R. A. Harmon, C. A. Kinney, and W. M. Crim, Jr. (U.S. Department of Energy, Washington, D.C.). *Turbomachinery International*, vol. 20, Mar. 1979, p. 29-32, 34. 18 refs.



Simultaneous generation of electricity and useful heat (cogeneration) is known to provide for the maximum utilization of the prime energy supplied as fuel to the conversion system. Cogeneration applications and experience in Western Europe are investigated (for possible use in the USA) in the context of energy conservation, environmental protection, and alternative energy sources. The principal conclusions are presented, noting that the most commonly used types of equipment are back pressure steam turbines or extraction condensing steam turbines. The status and outlook for future application of closed cycle gas turbines in cogeneration systems is considered, indicating that a relatively independent control of electric power and recovered heat should be an important incentive for closed cycle turbines. A.A.

**A79-28989**      **Gas turbine operating and maintenance experience in Saudi Arabia.** A. W. Anderson (Arabian American Oil Co., Technical Services Dept., Dhahran, Saudi Arabia). *Turbomachinery International*, vol. 20, Mar. 1979, p. 66-70.

Operation and maintenance of the gas turbines in Saudi Arabia, utilized to drive crude oil shipping pumps and process gas compressors, are discussed. Operation on wet, sour gas is taken into account, emphasizing the hot corrosion problem and the approaches taken to solve it. Intake air filtration is examined, indicating that as a result of an in depth study it was decided to retrofit the turbines with a three stage air filtration system. The methods for applying corrosion resistant coatings to the blades are considered, as are the overhaul logistics and the repair procedures. A.A.

**A79-29007 \* #**      **Evaluation of MOSTAS computer code for predicting dynamic loads in two-bladed wind turbines.** K. R. V. Kaza (NASA, Lewis Research Center, Cleveland; Toledo, University, Toledo, Ohio), D. C. Janetzke, and T. L. Sullivan (NASA, Lewis Research Center, Wind Energy Projects Office, Cleveland, Ohio). In: *Structures, Structural Dynamics, and Materials Conference*, 20th, St. Louis, Mo., April 4-6, 1979, Technical Papers on Structures and Materials. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 53-63. 13 refs. (AIAA 79-0733)

Calculated dynamic blade loads are compared with measured loads over a range of yaw stiffnesses of the DOE/NASA Mod-0 wind turbine to evaluate the performance of two versions of the MOSTAS computer code. The first version uses a time-averaged coefficient approximation in conjunction with a multiblade coordinate transformation for two-bladed rotors to solve the equations of motion by standard eigenanalysis. The results obtained with this approximate analysis do not agree with dynamic blade load amplifications at or close to resonance conditions. The results of the second version, which accounts for periodic coefficients while solving the equations by a time history integration, compare well with the measured data.

(Author)

**A79-29064 #**      **An introduction to the variable inertia flywheel (VIF).** D. Ullman (Union College, Schenectady, N.Y.) and H. Velkoff (Ohio State University, Columbus, Ohio). (*American Society of Mechanical Engineers and Canadian Society for Mechanical Engineering, Applied Mechanics, Fluids Engineering, and Bioengineering Conference*, Niagara Falls, N.Y., June 18-20, 1979, ASME Paper 79-APM-5.) ASME, Transactions, *Journal of Applied Mechanics*, vol. 46, Mar. 1979, p. 186-190. 11 refs.

A flywheel with variable moment of inertia, combining the functions of energy storage and power control is introduced. Potential designs are presented and the basic physical governing equations developed. Examples of the flywheel system powering a constant angular rate, frictional load, and an accelerating automobile are presented. Limitations of and potential for future development which become evident in the examples are discussed. (Author)

**A79-29277 #**      **Optimality criteria in the compensation of the longitudinal boundary effect in induction MHD machines (O**

**kriteriakh optimal'nosti pri kompensatsii prodol'nogo kraevogo effekta v induktsionnykh MGD-mashinakh).** Ia. Ia. Valdmans, R. R. Krishberg, and Ch. K. Mikriukov. *Magnitnaia Gidrodinamika*, Oct.-Dec. 1978, p. 141-143. 7 refs. In Russian.

**A79-29285 #**      **Calculation of the external electromagnetic field of closely spaced MHD machines (Raschet vneshnego elektromagnitnogo polia blizko raspolozhennykh MGD-mashin).** S. M. Apollonskii. *Magnitnaia Gidrodinamika*, Oct.-Dec. 1978, p. 88-92. 5 refs. In Russian.

A method is proposed for calculating the combined electromagnetic field of MHD machines located close to each other, by means of correction factors. Correction factors with respect to harmonics are obtained for calculating the combined field of two MHD sources. Illustrative calculations are presented and the results are compared with the experiment. V.P.

**A79-29286 #**      **Theoretical and computational analysis of MHD machines with two-layer windings and half-filled slots and the inductor edges (Teoreticheskoe i raschetnoe issledovanie MGD-mashin s dvukhsloinymi obmotkami i polupustymi pazami po kraiam induktora).** A. I. Vol'dek, N. A. Soldatenkova, and E. V. Tolvinskaya. *Magnitnaia Gidrodinamika*, Oct.-Dec. 1978, p. 101-106. In Russian.

**A79-29287 #**      **Two asymptotic solutions for analyzing the transverse edge effect in induction MHD machines (O dvukh predel'nykh resheniiakh dlia analiza poperechnogo kraevogo effekta v induktsionnykh MGD-mashinakh).** A. P. Rashchepkin. *Magnitnaia Gidrodinamika*, Oct.-Dec. 1978, p. 107-111. 5 refs. In Russian.

A comparison is made of the energetic characteristics of an induction machine, calculated on the basis of Okhremenko's (1968) and Veske's (1965) models. It is found that the energetic characteristics differ under conditions of a pronounced transverse edge effect, if the channel width is smaller than or equal to the pole pitch. The results of the two models are practically identical under any conditions, if the gap is smaller and the channel width is larger than twice the pole pitch value. V.P.

**A79-29288 #**      **Limit of formation of counterflows in plane linear induction MHD machines (Granitsa obrazovaniia protivonapravlennykh potokov v ploskolineinykh induktsionnykh MGD-mashinakh).** R. R. Krishberg. *Magnitnaia Gidrodinamika*, Oct.-Dec. 1978, p. 112-116. 10 refs. In Russian.

In high-power MHD machines, counterflows may arise at large magnetic Reynolds numbers, due to the demagnetizing action of secondary currents. In the present paper, the limits of formation secondary flows over the channel width are analyzed. It is shown experimentally that low-power pumps can be used to study such counterflows. In this case, high magnetic Reynolds numbers can be achieved by increasing the frequency. V.P.

**A79-29289 #**      **Equations of a conduction MHD ejector (Uravneniia konduktсионного MGD-stsepleniia).** Iu. A. Birzvalk. *Magnitnaia Gidrodinamika*, Oct.-Dec. 1978, p. 130-134. 10 refs. In Russian.

In the present paper, the linear equations of a classical conduction MHD ejector are obtained in an inductionless approximation, and are found to be analogous to those of an electric two-port network. The conditions for maximum efficiency are derived as a function of the output hydromechanical resistance. A relation for the optimal induction is obtained. The attainable efficiency values are identified, using a numerical example. V.P.

**A79-29297 #**      **Thermodynamic basis for combining cycles of heat producing power plants (Termodinamicheskie osnovy kombinirovaniia tsiklov teploenergeticheskikh ustanovok).** A. I. Andriushchenko (Saratovskii Politehnicheskii Institut, Saratov, USSR). *Energetika*, vol. 22, Jan. 1979, p. 51-54. In Russian.

The combination of different cycles is discussed as one of the ways of improving the efficiency of thermal power plants. It is shown that estimating fuel economy due to cycle combination

through the increase in thermal efficiency is valid only in the case of combined steam-steam cycles. In the case of superposing a gas cycle on top of a Brayton cycle, the result is not just an increase in thermal efficiency, but also a jump in the specific work of compression, which reduces fuel economy. P.T.H.

**A79-29298 #** Ways of improving steam-gas power plants (Puti sovershenstvovaniia parogazovykh ustanovok). I. S. Lazarenko, P. E. Kargin, V. T. Iurinskii, P. P. Emets, and I. Ia. Shestachenko (Nevinnomysskaia GRES, Nevinnomyssk; Novocherkasskii Politekhnicheskii Institut, Novocherkassk, USSR). *Energetika*, vol. 22, Jan. 1979, p. 55-60. 6 refs. In Russian.

It is shown that existing gas turbine systems used in steam-gas power plants can be simplified considerably in their design. Design simplifications are recommended that should reduce the size of gas turbine installations, reduce their metal volume, reduce the amount of assembly labor, and increase cost effectiveness. P.T.H.

**A79-29313** The economics of hydrogen and carbon monoxide separation with cuprous ammonium lactate solutions. L. R. Morrison, Jr. and R. I. Kermode (Kentucky, University, Lexington, Ky.). *Fuel Processing Technology*, vol. 2, Mar. 1979, p. 79-97. 22 refs.

A process is proposed for making hydrogen from coal which completely eliminates low temperature and reduces the amount of high temperature shift conversion. The resulting 1:1 H<sub>2</sub>-CO mixture is separated by absorption and reaction in a cuprous ammonium lactate solution at 1000 psia. The hydrogen is used for large scale coal liquefaction. Regeneration of the cuprous ammonium lactate solution results in a sulfur and particulate free carbon monoxide stream suitable for electric power generation. A comparison of the economics of this alternative with conventional high and low temperature shift conversion shows an increase in the process efficiency as well as reduction in the amount of capital required. This, plus other savings, results in carbon monoxide costing 0.988 \$/MSCF or 3.095 \$/MM Btu. On an equivalent Btu basis, this is 70.9% of the cost of hydrogen by conventional coal conversion. Thus, substitution of separation for shift conversion results in a substantial product cost reduction. (Author)

**A79-29314** Coal gasification studies. III - Reduction in the presence of some metal iodides and iron halides. R. Butler and A. Snelson (IIT Research Institute, Chicago, Ill.). *Fuel Processing Technology*, vol. 2, Mar. 1979, p. 99-121. 15 refs. Research supported by the Consolidated Natural Gas Service Co.

**A79-29315** Reaction mechanism of alkali-alcohol treatment of coal. M. Makabe and K. Ouchi (Hokkaido University, Sapporo, Japan). *Fuel Processing Technology*, vol. 2, Mar. 1979, p. 131-141. 11 refs. Research supported by the Iwatani Naoji Foundation.

Taiheiyō coal was reacted with ethanol-sodium hydroxide at 260-400 C for 1-22 hours. The products dissolved almost completely in pyridine. Structural analysis was carried out for the pyridine soluble part to elucidate the reaction mechanism. The only change was a reduction in molecular weight. A very slight saturation reaction of aromatic rings also took place, but this did not affect the structural image of the products very much. The main reaction may be splitting of ether linkages resulting in the reduction of molecular weight and at higher temperature dehydration has followed. This somewhat reduced the solubility in pyridine. (Author)

**A79-29335** Metropolitan work-trip energy consumption patterns. S. Soot and A. Sen (Illinois, University, Chicago, Ill.). *Traffic Quarterly*, vol. 33, Apr. 1979, p. 275-295. 14 refs. Research supported by the U.S. Department of Transportation.

Patterns of energy consumption for journeys to work in a metropolitan area are examined. The relationship between these patterns and urban structure is demonstrated. Population and

geographic variables that affect energy use are identified by performing statistical and cartographic analyses on census data relating to distances of work trips and choice of transportation mode in the Chicago area. The results obtained verify the expectation that low-density automobile-oriented suburbs are far more energy consumptive than high-density mass-transit-oriented inner-city locations and also indicate that young household heads (aged 25-34) account for a disproportionately high rate of energy use. F.G.M.

**A79-29337** Application of kinetic energy storage to transportation systems. L. J. Lawson (AiResearch Manufacturing Company of California, Torrance, Calif.). *High Speed Ground Transportation Journal*, vol. 12, Fall 1978, p. 1-27. 9 refs.

The recent rediscovery of the flywheel as an effective energy storage system, coupled with the growing public and government awareness of the need for energy-efficient passenger vehicles, has led to a resurgence of development activity in kinetic energy storage systems. Programs are currently underway by UMTA and DOE which will make use of pure flywheel and flywheel-assisted propulsion for a wide range of vehicles including subway cars, commuter trains, transit buses, passenger automobiles, and postal vans. The background and status of these ongoing activities is described, along with other planned flywheel applications, such as the recuperation of braking energy from freight trains on long downgrades. (Author)

**A79-29338** The influence of systems and operations on rapid rail energy utilization. H. L. Tucker, Jr. (U.S. Department of Transportation, Washington, D.C.). (Advanced Transit Association, International Conference, Indianapolis, Ind., Apr. 25-28, 1978.) *High Speed Ground Transportation Journal*, vol. 12, Fall 1978, p. 29-43. 11 refs.

The impacts that the various elements of a rail system have on rail energy intensiveness are investigated. Attention is given to system energy profiles, vehicle weight, propulsion system energy requirements, self-steering trucks, manual vs automatic train control, aspects of system design, operational impacts on energy utilization, programmed acceleration, and scheduling/skip-stop. The individual impacts of systems and operations on rapid rail energy utilization are summarized in a table. G.R.

**A79-29339** Bus priority system studies. P. G. Michalopoulos (Minnesota, University, Minneapolis, Minn.). *High Speed Ground Transportation Journal*, vol. 12, Fall 1978, p. 45-71.

Priority treatment for buses on urban roadways has been implemented in various forms in an attempt to reduce bus operating costs and encourage ridership. In the reported investigations instrumented buses were employed to study the operational effectiveness of bus priority schemes. The studies were carried out in Miami, Florida, in connection with a demonstration project under the sponsorship of the U.S. and Florida Departments of Transportation. A brief description is given of the operating strategies for the bus priority system which was evaluated. An automated data collection and analysis technique using instrumented buses is discussed and the results of an application of this technique to the evaluation of system effectiveness is considered. G.R.

**A79-29371** Energy statistics for large wind turbine arrays. C. G. Justus and A. S. Mikhail (Georgia Institute of Technology, Atlanta, Ga.). *Wind Engineering*, vol. 2, no. 4, 1978, p. 184-202. 8 refs. Contract No. EY-76-S-06-2439.

Results of studies of large arrays of wind energy conversion systems (WECS) are summarized and synthesized into a methodology whereby array wind speed distributions and array power output distributions can be calculated for arrays of any number of sites and any spatial size. Required input for the method consists of: (1) array mean wind speed, (2) maximum distance between sites within an array, (3) number of sites in the array, and (4) standard deviation (or Weibull scale factor), either measured or inferred from reference statistical data. Sample results using this methodology are presented along with sensitivity analyses of the various input parameters. The sensitivity analysis results show that mean wind speed (including its

seasonal and diurnal variation pattern, if important) is the most important factor in the array model. Sensitivity of the array model to other input parameters is about half as much as the mean wind speed sensitivity. (Author)

**A79-29372** Pressure measurements on wind tunnel models of the Aylesbury experimental house. J. D. Holmes and R. J. Best (North Queensland, James Cook University, Townsville, Australia). *Wind Engineering*, vol. 2, no. 4, 1978, p. 203-220. 10 refs. Research supported by the Australian Housing Research Council.

**A79-29373** Large-scale introduction of wind power stations in the Swedish grid - A simulation study. L. Larsson (Lund Institute of Technology, Lund, Sweden). *Wind Engineering*, vol. 2, no. 4, 1978, p. 221-233.

**A79-29374** Wind power and electric utilities - A review of the problems and prospects. H. Davitian (Brookhaven National Laboratory, Upton, N.Y.). *Wind Engineering*, vol. 2, no. 4, 1978, p. 234-255. 12 refs.

The highly varying character of the power output and the large number of machines required to generate significant amounts of energy are serious obstacles to the large-scale implementation of wind turbines. An attempt is made to summarize several aspects of the current understanding of the potential for and the problems associated with the use of large wind machines. Particular attention is given to the problems related to the use of wind power by electric utilities, as these utilities are the largest potential market for wind machines. To gain insight into these problems, the characteristics of wind variability are explored along with the dynamic aspects of utility operations. Methods and results are outlined of recently completed and ongoing studies which attempt to incorporate the unique characteristics of wind machines into utility analytic techniques with a view to compute realistic estimates of the economic value of wind machines to utilities. S.D.

**A79-29383 \* #** Effect of broadened-specification fuels on aircraft engines and fuel systems. R. A. Rudey (NASA, Lewis Research Center, Cleveland, Ohio). In: International Symposium on Air Breathing Engines, 4th, Orlando, Fla., April 1-6, 1979, Proceedings. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 53-69. 23 refs. (AIAA 79-7008)

A wide variety of studies on the potential effects of broadened-specification fuels on future aircraft engines and fuel systems are summarized. The compositions and characteristics of aircraft fuels that may be derived from current and future crude-oil sources are described, and the most critical properties that may affect aircraft engines and fuel systems are identified and discussed. The problems that are most likely to be encountered because of changes in selected fuel properties are described; and the related effects on engine performance, component durability and maintenance, and aircraft fuel-system performance are discussed. The ability of current technology to accept possible future fuel-specification changes is discussed, and selected technological advances that can reduce the severity of the potential problems are illustrated. (Author)

**A79-29384** # Testing to assess the affect of degraded fuel specifications on the cold start ability of a T63-A-700 engine. W. L. Macmillan (Department of National Defence, Ottawa, Canada). In: International Symposium on Air Breathing Engines, 4th, Orlando, Fla., April 1-6, 1979, Proceedings. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 71-77. 7 refs. (AIAA 79-7009)

In the interests of jet fuel availability, the Canadian commercial wide-cut fuel specification has recently been relaxed by increasing the freeze point. An increased freeze point implies an increased low-temperature viscosity and associated cold-starting difficulties. To identify the amount of cold-start degradation to be expected with such fuels, the Canadian Forces commissioned testing to examine the cold start ability of an Allison T63-A-700 turboshaft engine using

four fuels ranging from typical kerosene Jet A-1 to NATO wide cut F-40. The two intermediate fuels were wide cut fuels blended to have specific freeze points agreeing with the new fuel specifications. For the engine under test, the effect of fuel properties on cold-start ability was evident with the relaxed wide-cut fuel producing a 20 C degradation in starting ability compared to the typical NATO F-40 fuel. (Author)

**A79-29426 \*** Application of the superposition principle to solar-cell analysis. F. A. Lindholm, J. G. Fossum (Florida, University, Gainesville, Fla.), and E. L. Burgess (Sandia Laboratories, Albuquerque, N. Mex.). *IEEE Transactions on Electron Devices*, vol. ED-26, Mar. 1979, p. 165-171. 21 refs. Research supported by the U.S. Department of Energy and NASA.

The superposition principle of differential-equation theory - which applies if and only if the relevant boundary-value problems are linear - is used to derive the widely used shifting approximation that the current-voltage characteristic of an illuminated solar cell is the dark current-voltage characteristic shifted by the short-circuit photocurrent. Analytical methods are presented to treat cases where shifting is not strictly valid. Well-defined conditions necessary for superposition to apply are established. For high injection in the base region, the method of analysis accurately yields the dependence of the open-circuit voltage on the short-circuit current (or the illumination level). S.D.

**A79-29428** The design and fabrication of CdS/Cu<sub>2</sub>S cells of 8.5-percent conversion efficiency. W. E. Devaney (SES, Inc., Newark, Del.), A. M. Barnett, J. D. Meakin (Delaware, University, Newark, Del.), and G. M. Storti (Solarex Corp., Rockville, Md.). *IEEE Transactions on Electron Devices*, vol. ED-26, Mar. 1979, p. 205-210. 13 refs. Contract No. E(49-18)-2538.

Changes in CdS/Cu<sub>2</sub>S solar cell design and fabrication techniques are described which have now resulted in sunlight efficiencies of 8.5%. The efficiency optimization program is based on the detailed energy loss analysis of Rothwarf and Barnett (1977). Three new processing technologies are developed; (1) high-transmission vapor-deposited gold grids are developed for polycrystalline CdS/Cu<sub>2</sub>S cells without producing efficiency-degrading shorts or shunt resistances; (2) a single-layer antireflection coating of silicon monoxide on a textured cell surface is developed to reduce first surface reflection losses to about 4%; and (3) substantial heat treatments are developed for this cell structure resulting in enhanced Cu<sub>2</sub>S stoichiometry and corresponding high short-circuit currents. This fabrication technology has resulted in improved cell efficiency while maintaining the previously achieved high degree of cell reproducibility. S.D.

**A79-29487** International Conference on Electric Vehicle Development, London, England, May 31, June 1, 1977, Proceedings. Conference sponsored by the Chartered Institute of Transport, Electrical Research Association, International Union of Producers and Distributors of Electrical Energy, et al. Hitchin, Herts., England, Peter Peregrinus, Ltd. (PPL Conference Publication, No. 14), 1977. 108 p. \$15.30.

Papers are presented on development work for the implementation of electric road vehicles. Areas dealt with are battery power and economics, operational systems and supply networks, engineering design and power sources, test programs, fleet and individual vehicles and programs of electric vehicle development in various nations. Specific topics considered include lead acid and alkaline batteries, support services for electric vehicles, the compatibility of electric vehicles with an urban environment, electric vehicle design, hybrid vehicles, the implementation of electric bus fleets, and government support for the electric vehicle industry. A.L.W.

**A79-29488** Prospects for improvements in lead-acid batteries. R. G. Acton and P. Sutcliffe (Oldham and Son, Ltd., Denton, Manchester, England). In: International Conference on Electric

Vehicle Development, London, England, May 31, June 1, 1977, Proceedings. Hitchin, Herts., England, Peter Peregrinus, Ltd., 1977, p. 3-5. 5 refs.

The prospects for improving lead acid batteries for electric vehicles in the areas of energy density, recharging time and maintenance are assessed. It is found that battery weight reduction can be achieved by replacing positive grid plates with tubular components, using plastic or lighter metal grids for negative plates and by using 'through the wall' techniques for intercell connectors. An increase in energy density to 45 Wh/kg for a five hour discharge is foreseen. Automatic and semi-automatic watering systems have been developed to reduce the amount of maintenance. Methods proposed to enable rapid charging (in less than an hour) without excessive temperature rise include a system of high speed pulse discharging during the charging process to prevent electrode polarization and a new battery design based on foil technology. A.L.W.

**A79-29489** The energy and resource implications associated with the widespread use of electric vehicles. G. Charlesworth (Open University, Milton Keynes, Bucks., England). In: International Conference on Electric Vehicle Development, London, England, May 31, June 1, 1977, Proceedings. Hitchin, Herts., England, Peter Peregrinus, Ltd., 1977, p. 6-13.

The comparative economics of future internal combustion engine (ICE) and electric battery vehicles are illustrated by a comparison of energy and materials efficiencies. ICE and electric vehicles projected for the years 1990, 2000, and 2025 are compared on the bases of weight, fuel and payload efficiencies, energy demand, total costs and materials requirements. It is concluded that over the next 45 years, electric vehicles using high energy density batteries could be developed and show a significant energy advantage over ICE vehicles fuelled by coal-derived liquids. Unless battery life is extended to more than 500 deep cycles, however, electric vehicles are not likely to show a cash cost advantage. It is noted that electric vehicles will always suffer a range limitation unless extensive battery exchange facilities are established, and implementation would require changes in land use planning and public transportation. A.L.W.

**A79-29490** Recent developments in power sources with special emphasis on alkaline batteries. H. G. Plust (Deutsche Automobilgesellschaft mbH, Esslingen, West Germany). In: International Conference on Electric Vehicle Development, London, England, May 31, June 1, 1977, Proceedings. Hitchin, Herts., England, Peter Peregrinus, Ltd., 1977, p. 14-24. 30 refs.

Recent developments in propulsion batteries for electric road vehicles are discussed, emphasizing alkaline batteries. Lead acid batteries are considered inadequate to meet energy density requirements of 40 to 60 Wh/kg for two-hour discharges and dissolved lead secondary batteries presently suffer from operating problems. In nickel-zinc batteries, nonsintered bonded positive nickel oxide electrodes are being developed to replace expensive sintered electrodes and negative electrodes and cell separators are being improved to prevent shape changes and the formation of dendrites. Larger nickel-zinc batteries (up to 300 A h for 2 h) are also being produced. Nickel-iron batteries with nickel oxide electrodes are considered to show great promise. Iron-air and zinc-air batteries can achieve high energy densities, but have a low charging/discharging efficiency (29%). Nickel-hydrogen and lithium-water-air batteries are also possible power sources for electric vehicles. A.L.W.

**A79-29491** The role of the battery electric vehicle. G. Ratcliff (Electricity Council, Research Centre, Capenhurst, Ches., England). In: International Conference on Electric Vehicle Development, London, England, May 31, June 1, 1977, Proceedings. Hitchin, Herts., England, Peter Peregrinus, Ltd., 1977, p. 29, 30.

Possible applications of battery-powered electric road vehicles are discussed, taking into consideration the limitations imposed by battery parameters. The electric battery requires that electric vehicles be much heavier, have a smaller range and take longer to refuel than gasoline-driven vehicles. The use pattern to which electric vehicles are limited is compatible with such applications as postal delivery vans, light goods service vehicles and urban buses, and is unsuitable for personal private vehicles. It is pointed out that electric vehicles can be designed to have good road performance, with greatest efficiency resulting if the motor operates at high speed with a gear box used to regulate vehicle speed. A conventional van design has been converted to electric power and has been found to have an acceleration of 0 to 30 mph in 12 sec and a maximum speed of 50 mph. A.L.W.

**A79-29492** Support services for electric vehicles. M. Bradford and B. Buss (Electrical Research Association, Ltd., Leatherhead, Surrey, England). In: International Conference on Electric Vehicle Development, London, England, May 31, June 1, 1977, Proceedings. Hitchin, Herts., England, Peter Peregrinus, Ltd., 1977, p. 31-36. 9 refs.

Means of supplying energy to individually owned electric vehicles are examined, emphasizing a system of battery exchange stations. Battery charging in situ where the car is parked has the disadvantages of requiring a considerable amount of time for recharging, making extended journeys inconvenient, and using devices which can be safety hazards. A battery exchange station would charge discharged batteries obtained in exchange for charged ones by means of electricity supplied to the station. A fully automated system can be foreseen for battery handling, which would, however, require standardization of battery and vehicle parameters. The cost of a battery exchange station is considered to be higher than that of a gasoline station, but costs can be minimized by a study of car, battery and station interrelationships. A.L.W.

**A79-29493** Electric vehicles - Can they be fitted into urban Britain. D. Bayliss (Greater London Council, London, England). In: International Conference on Electric Vehicle Development, London, England, May 31, June 1, 1977, Proceedings. Hitchin, Herts., England, Peter Peregrinus, Ltd., 1977, p. 37-45. 35 refs.

The prospects for implementing electric road vehicles in urban Britain, primarily London, are examined. Existing urban travel patterns are analyzed and on the basis of this information a private electric passenger car with a range of 100 km, cruising velocity of 75 km/h and an acceleration of 0 to 65 km/h in 10 sec is specified. In a future system, this car could be complemented by an internal combustion engine car rental service. Electric taxis would be possible if a standardized battery exchange system could be implemented and electric buses and delivery vehicles are also feasible. Present technology, however, does not allow necessary specifications to be met and electric vehicles would not be competitive with diesel-powered vehicles. It is concluded that a spectrum of vehicles, from purely electric through hybrid to purely internal combustion, is most probable for the future. A.L.W.

**A79-29494** Road vehicles with combined, at least partly electrical driving systems and energy supplies. H.-G. Müller (Gesellschaft für elektrischen Strassenverkehr mbH, West Germany). In: International Conference on Electric Vehicle Development, London, England, May 31, June 1, 1977, Proceedings. Hitchin, Herts., England, Peter Peregrinus, Ltd., 1977, p. 48-52. 9 refs.

Systems of combined propulsion, in which one component is electrical, for road vehicles are discussed. The systems consist of a combined energy supply, which can be implemented by means of different kinds of energy (for example electric and diesel power) or by different forms of the same kind of energy (for example overhead wires and batteries), and energy storage systems, including tanks for liquids, metal alloys for the storage of hydrogen as hydrides, electric batteries and mechanical energy storage systems (flywheels). Drive

systems under consideration, the internal combustion engine and the dc electric motor, are compared. Examples of vehicles with combined propulsion are presented, including a bus run on electricity alternately supplied from overhead wires and an electric battery, and series and parallel variants of internal combustion engine/electric battery powered hybrid vehicles. A.L.W.

**A79-29495** The fleet operator's viewpoint. A. M. Munro (Greater Manchester Passenger Transport Executive, Manchester, England). In: International Conference on Electric Vehicle Development, London, England, May 31, June 1, 1977, Proceedings. Hitchin, Herts., England, Peter Peregrinus, Ltd., 1977, p. 64-67.

Results of two years operation of two prototype electric buses are discussed. Development of electric buses was undertaken due to the applicability of bus service to electric vehicles and the improvements in reliability and noise expected. Specifications of the two prototype buses are given, noting that both are single-decked, medium sized and employ regenerative braking systems. The performance of the buses was found to be satisfactory, with driver and passenger reactions favorable, however bus availability in both cases was found to be less than 50%, in comparison with a diesel bus availability of 80%. The low availability found is explained by the experimental and unique nature of the equipment. It is concluded that electric buses are possible, but further tests of economic feasibility are required. A.L.W.

**A79-29496** Developing electric vehicles. G. G. Harding (Lucas Batteries, Ltd., Birmingham, England). In: International Conference on Electric Vehicle Development, London, England, May 31, June 1, 1977, Proceedings. Hitchin, Herts., England, Peter Peregrinus, Ltd., 1977, p. 68-78.

The development of electric battery vehicles undertaken by Lucas Batteries Limited is presented. Early work was done on a test vehicle for a zinc-air battery, but when the battery was abandoned, the experience gained was applied to the conversion to electric power of a pickup truck and two vans. The next stage was to build a number of development vehicles for testing by actual service, with 20 converted vans having achieved over 520 vehicle weeks of service. The design of the most recent vehicles seeks to incorporate an efficient drive system into a standard, relatively low cost, vehicle. Performance tests to be undergone by the latest vehicle are described and possible safety hazards discussed. It has been found that the energy consumption of the electric vehicles is comparable to that of internal combustion engine vehicles, and would be much less if all energy were to come from coal. A.L.W.

**A79-29497** Latest developments in sponsored test programs for electric vehicles in France. J. Gallot (Electricité de France, Paris, France). In: International Conference on Electric Vehicle Development, London, England, May 31, June 1, 1977, Proceedings. Hitchin, Herts., England, Peter Peregrinus, Ltd., 1977, p. 79-84.

**A79-29498** Electric car project of the Eindhoven University of Technology. W. A. Koumans (Eindhoven, Technische Hogeschool, Eindhoven, Netherlands). In: International Conference on Electric Vehicle Development, London, England, May 31, June 1, 1977, Proceedings. Hitchin, Herts., England, Peter Peregrinus, Ltd., 1977, p. 87-90.

**A79-29499** An electric propulsion system for a town and city bus. C. P. Keizer (Delft, Technische Hogeschool, Delft, Netherlands). In: International Conference on Electric Vehicle Development, London, England, May 31, June 1, 1977, Proceedings. Hitchin, Herts., England, Peter Peregrinus, Ltd., 1977, p. 91, 92.

The design of an electric propulsion system for a city bus is presented and battery parameters are discussed. The bus is designed to accelerate from 0 to 30 km/h in 14 sec, have a maximum speed of 70 km/h and carry a total weight of 16 tons. The motor is a separately excited, continuous 120 kW machine controlled by two

power converters, and regenerative braking is employed. It is calculated that the actual amount of energy that can be extracted from a lead acid battery is 15.3 Wh/kg and about 100 Wh/(ton km) is required for bus operation. A battery mass of 6.5 kg is then required for one ton to be moved one km. If the total mass of the bus is 20 tons (including a trailer for the battery), the actual energy consumption will be 2000 Wh/km and the range with a six ton battery will be 46 km. A.L.W.

**A79-29575** Energy conversion engineering. R. C. Bailie (West Virginia University; Environmental Energy Engineering, Inc., Morgantown, W. Va.). Reading, Mass., Addison-Wesley Publishing Co. (Energy Science and Technology, No. 1), 1978. 554 p. \$19.50.

The book represents a teaching text and not a state-of-the-art review or a data source book on energy conversion systems. The information presented aims at providing some of the analytical tools that will allow many of the arguments about energy policy to be reduced to numerical values. The discussion covers the laws of thermodynamics, chemical equilibrium, chemical reaction kinetics, and their application to energy conversion systems. Problem areas of interest include combustion of fossil fuel for heat and power, coal gasification and liquefaction, nuclear energy, solar energy, and environmental considerations. S.D.

**A79-29601** Limits to wind power utilization. M. R. Gustavson (California, University, Livermore, Calif.). *Science*, vol. 204, Apr. 6, 1979, p. 13-17. 35 refs.

The geophysical, environmental and practical factors limiting the total power that can be extracted from the wind are examined. The total power supplied by the sun to the earth is estimated to be  $1.8 \times 10^{10}$  to the 17th W, of which  $1.3 \times 10^{10}$  to the 15th W is converted to wind energy available at the surface of the earth. It is estimated that 10% of the wind energy available could be utilized without extreme effects on climate, giving a limit of  $1.3 \times 10^{10}$  to the 14th W, or  $2 \times 10^{10}$  to the 12th W for the land area of the United States. Friction, energy conversion efficiencies, design velocity limits, relations between flow rate and pressure drop, and degradation from packing of collectors reduce the amount of extractable power to about 40% of that available. Even with these limitations imposed, available wind energy is shown to be considerably greater than usable hydropower, geothermal energy and tidal energy. A.L.W.

**A79-29624** Heat pump technology for saving energy. Edited by M. J. Collie. Park Ridge, N.J., Noyes Data Corp. (Energy Technology Review, No. 39), 1979. 357 p. \$39.

Basic concepts of the heat pump, comparison of water-source and air-source heat pumps in northern environment, and evaluation of the air-to-air heat pump for residential use are described. Attention is given to three experimental studies (residential air-to-air heat pump, water-to-air heat pump using thermal effluent, and heat pump system with thermal storage), to the Annual Cycle Energy System (ACES) water-to-air heat pump unit, and to the solar-assisted heat pump. Also discussed are the performance evaluation of a three-ton air-to-air heat pump, heat pump performance improvement by using a capacity-controlled compressor, and control of the noise generated residential heat pumps. S.D.

**A79-29625** Passive solar energy design and materials. Edited by J. K. Paul. Park Ridge, N.J., Noyes Data Corp. (Energy Technology Review, No. 41), 1979. 398 p. \$39.

Passive solar approaches are examined, taking into account direct gain, the thermal storage wall, the solar greenhouse, the roof pond, and the convective loop. Various system components are considered. Window treatments are discussed along with thermal storage, freon-activated controls, hinged skylid shutters and nightwall clips, beadwalls, thermic diode solar panels, heat pipes, the Skytherm roof pond, the energy roof, Suncatcher and Cool Pool, and the solar room. A description is provided of case studies and applications. Attention is given to direct gain, indirect gain, and isolated gain. G.R.

**A79-29647** Symmetrical and asymmetrical ideal cylindrical radiation transformers and concentrators. D. R. Mills and J. E. Giutronich (New South Wales, University, Kensington, Australia). *Optical Society of America, Journal*, vol. 69, Feb. 1979, p. 325-328. 7 refs.

Ideal cylindrical radiation transformers and concentrators are examined in both asymmetrical and symmetrical forms. Symmetrical ideal transformers are found to give the lowest peak concentration for a given angle of acceptance. Average concentration for uniform diffuse radiation or a distant point source of constant apparent angular velocity is found to be independent of the symmetry of the transformer; for an apparently accelerating source such as the sun, however, an asymmetrical transformer can give higher performance than a symmetrical unit when averaged over time. (Author)

**A79-29794** Feasibility of MHD-ac induction electric power plant. K. Denno (New Jersey Institute of Technology, Newark, N.J.). In: Canadian Communications and Power Conference, Montreal, Canada, October 18-20, 1978, Proceedings.

New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p. 349-352. 5 refs.

The reported investigation deals with real and factual situations for the effective utilization of a rich conducting plasma located in the divertor channel and exhaust chamber of the tokamak fusion reactor. The exhaust chamber, which is almost of cylindrical geometry, is expected to serve as the operating MHD channel with the conducting plasma entering at circumferential velocity. The exciting field is generated by a time-varying sinusoidal current sheet. Specific and procedural solutions are presented for the cylindrical distribution of the applied and induced magnetic fields, the induced current density and voltage, and the generated ac power output. G.R.

**A79-29795** Development and application of techniques to evaluate cogeneration impacts. F. E. Wicks, W. Rutz, M. Becker, J. Sergison, G. Mulligan, and S. Yerazunis (Rensselaer Polytechnic Institute, Troy, N.Y.). In: Canadian Communications and Power Conference, Montreal, Canada, October 18-20, 1978, Proceedings.

New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p. 357-360.

Cogeneration is the simultaneous production of electric energy and process heat from a single plant. Usually the higher temperature heat powers the electric generation and the lower temperature exhaust provides the process heat. These classes of cogeneration are called topping cycles. There are also some processes that require high temperature heat and thus the electric generating engine can be driven by the intermediate temperature discharge heat from the process. These classes of cogeneration are called bottoming cycles. All fuel consuming electric generating engines or drivers can be applied to cogeneration. Attention is given to cogeneration operating patterns and the impact of cogeneration upon the existing system.

G.R.

**A79-29796 \*** Space solar power - An energy alternative. R. W. Johnson (NASA, Washington, D.C.; Grumman Aerospace Corp., Bethpage, N.Y.). In: Canadian Communications and Power Conference, Montreal, Canada, October 18-20, 1978, Proceedings.

New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p. 369-372.

The space solar power concept is concerned with the use of a Space Power Satellite (SPS) which orbits the earth at geostationary altitude. Two large symmetrical solar collectors convert solar energy directly to electricity using photovoltaic cells woven into blankets. The dc electricity is directed to microwave generators incorporated in a transmitting antenna located between the solar collectors. The antenna directs the microwave beam to a receiving antenna on earth where the microwave energy is efficiently converted back to dc electricity. The SPS design promises 30-year and beyond lifetimes. The SPS is relatively pollution free as it promises earth-equivalence of 80-85% efficient ground-based thermal power plant. G.R.

**A79-29797** Some recent developments in wind and ocean power systems. J. T. Yen (Grumman Aerospace Corp., Bethpage, N.Y.). In: Canadian Communications and Power Conference, Montreal, Canada, October 18-20, 1978, Proceedings.

New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p. 373-377. 6 refs.

A description is presented of a tornado-type wind energy system and its extension. Immense amounts of wind energy will be collected by a stationary and omni-directional collector which is a slotted cylinder fitted with adjustable vanes at its periphery. Collected wind energy is guided by the vanes to form a vortex or a 'confined tornado' within the collector. The low-pressure core of the vortex is then used to greatly reduce the back pressure of a turbine which is located directly below the vortex core. The underside of the turbine is connected to the ambient atmosphere through a bottom inlet.

G.R.

**A79-29798** Control problems of the magnetohydrodynamic electrical power generation in power station cooperating with electrical power system. J. Stiller, A. Grzybowski, and I. Grzadzinski (Poznan, Politechnika, Poznan, Poland). In: Canadian Communications and Power Conference, Montreal, Canada, October 18-20, 1978, Proceedings.

New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p. 378-381. 5 refs.

**A79-29799** A Variable Speed Constant Frequency (VSCF) wind generator for low power applications. V. I. John and J. Sones (Queen's University, Kingston, Ontario, Canada). In: Canadian Communications and Power Conference, Montreal, Canada, October 18-20, 1978, Proceedings.

New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p. 382-385.

A polyphase commutator motor of the Schrage type is used as a Variable Speed Constant Frequency (VSCF) wind generator. An automatic control system which maintains continuous generator operation for a wide range of speeds is described. Test results and computed results (based on an equivalent circuit) are obtained for efficiency, power output, powerfactor and mechanical torque for different operating speeds, to demonstrate the feasibility of Schrage generator for windpower applications. (Author)

**A79-29800** Control strategy for a variable-speed wind energy conversion system (Stratégie de commande pour un système de conversion de l'énergie éolienne à vitesse variable). A. Jacob, D. Veillette, and V. Rajagopalan (Québec, Université, Trois-Rivières, Canada). In: Canadian Communications and Power Conference, Montreal, Canada, October 18-20, 1978, Proceedings.

New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p. 528-531. 10 refs. In French. Research supported by the Department of Energy, Mines, and Resources, National Research Council and Université du Québec.

A control concept for a variable-speed wind energy conversion system is proposed, for which a self-excited asynchronous cage generator is used along with a system of thyristor converters. The control loops are the following: (1) regulation of the entrainment speed as function of available mechanical energy by acting on the resistance couple of the asynchronous generator; (2) control of electric power delivered to the asynchronous machine, functioning as a motor, for startup of the vertical axis wind converter, and (3) limitation of the slip value, and by consequence, of the induction currents in the presence of sudden variations of input parameters.

P.T.H.

**A79-29936 #** Remote sensing and mine subsidence in Pennsylvania. O. R. Russell (Earth Satellite Corp., Washington, D.C.), R. V. Amato, and T. V. Leshendok (U.S. Geological Survey, Washington, D.C.). (*American Society of Civil Engineers, National Spring Convention and Continuing Education Program, Pittsburgh, Pa., Apr. 24-28, 1978.*) *ASCE, Transportation Engineering Journal*, vol. 105, Mar. 1979, p. 185-198.

It is pointed out that during the more than 200 years of mining activity in the Northern Anthracite Field of Pennsylvania more than 50% of the original anthracite reserves have been removed. This undermining of the area has caused much subsidence, which in many instances has damaged streets, railroads, private property, and sections of the extensive river flood-prevention system. Mine subsidence is a continuing problem. The U.S. Bureau of Mines estimates that by the year 2000, over 1,500,000 acres of land will have been affected. Subsidence hazards data are essential to state and local planning agencies before any major construction can be undertaken. In an attempt to determine a more efficient and cost effective means of identifying subsidence problem areas, the utility of aerial remote sensing has been examined. The underlying strategy of the project was to recognize that the overall problem is to develop a better approach to land-use management. G.R.

**A79-29939** The impact of alternate energy resources on the future supply of electric power. J. A. Belding (U.S. Department of Energy, Div. of Power Systems, Washington, D.C.): (*Institute of Electrical and Electronics Engineers, Summer Meeting, Los Angeles, Calif., July 16-21, 1978, Paper F 78 672-8.*) *IEEE Transactions on Power Apparatus and Systems*, vol. PAS-98, Mar.-Apr. 1979, p. 554-559; Discussion, p. 559, 560. 21 refs.

Given the limitations of the import solution, and the declining domestic supply of oil and natural gas, it is apparent that a shift must occur to alternate fuel resources, coal and nuclear for now, and solar and geothermal in the future. The adoption of these alternate fuels will not be easy, however. It will be constrained by a number of technological and nontechnological problems. The reported investigation deals partly with the technological dimensions of coal and nuclear electricity generation. However, the nontechnological problems are also considered, giving attention to environmental, economic, foreign policy, and security issues. G.R.

**A79-29942 #** Homopolar generator energy storage for fusion reactors. E. K. Inall (Australian National University, Canberra, Australia). *Institution of Engineers (Australia), Electrical Engineering Transactions*, vol. EE 14, no. 2, 1978, p. 83-87.

The paper outlines the design features of the 560-MJ homopolar generator (HPG) presently operating at the Australian National University. There are four or five types of plasma machine for which the ongoing programs aim at the construction of fusion power reactors. Three of these, namely tokamaks, stellarators and theta pinches need the energy storage which HPGs can provide. The design of HPGs to suit the needs of such machines is considered. S.D.

**A79-29974** Instrumentation for in situ coal gasification. IV - Seismic and acoustic techniques for remote monitoring. L. W. Beckham, H. D. Garbin, and D. A. Northrop (Sandia Laboratories, Albuquerque, N. Mex.). *In Situ*, vol. 3, no. 1, 1979, p. 1-31. 16 refs.

**A79-29975** Oil shale retorting - A correlation of selected infrared absorbance bands with process heating rates and oil yield. R. A. Evans and J. H. Campbell. *In Situ*, vol. 3, no. 1, 1979, p. 33-51. 8 refs. Contract No. W-7405-eng-48.

**A79-30123 #** Thermal conductivity of crystalline rocks associated with energy extraction for hot dry rock geothermal systems. W. L. Sibbitt, J. G. Dodson, and J. W. Tester (California, University, Los Alamos, N. Mex.). *Journal of Geophysical Research*, vol. 84, Mar. 10, 1979, p. 1117-1124. 25 refs. Research supported by the U.S. Department of Energy.

**A79-30172** The potential for solar energy development. P. E. Glaser (Arthur D. Little, Inc., Cambridge, Mass.). *Technology in Society*, vol. 1, Spring 1979, p. 55-66. 12 refs.

The costs of solar water and space heating installations for residences and commercial buildings are discussed, and the develop-

ment programs for Solar Power Satellites are reviewed. Projected U.S. electrical generating capacities from wind power, solar thermal power, photovoltaics, ocean thermal energy, biomass conversion and Solar Power Satellites are reported for the years 2000 and 2020. The role of Solar Power Satellites in providing electrical generating capacity for the U.S. may be significant by 2020. J.M.B.

**A79-30175** Energy, resources, and policy. R. C. Dorf (California, University, Davis, Calif.). Reading, Mass., Addison-Wesley Publishing Co., Inc., 1978. 500 p. 472 refs. \$15.95.

The book is an introduction to the uses of energy, supplies of fossil fuels, alternative energy sources, and various policy alternatives for the U.S.A. and the world. The history of energy use and projections for future consumptions are outlined. The fossil fuels are discussed along with electric power as a carrier of energy. The uses of energy in transportation and agriculture are explored. Hydroelectric, wind, tidal, geothermal, and nuclear power generating techniques are emphasized. Solar energy methods are considered along with alternative conversion and storage systems. Attention is given to the conservation of energy as well as to the relationship of energy and the environment. Also discussed are energy economics, policy and underlying international factors. S.D.

**A79-30204 #** Utilisation of solid waste. K. Balu (Regional Research Laboratory, Computer Div., Hyderabad, India). *Indian Journal of Air Pollution Control*, vol. 1, July 1978, p. 109-114. 5 refs.

The prime solution to the present energy crisis is the recovery of latent energy from waste materials, for solid waste contains recoverable energy and it merely needs to be released. The paper is concerned with classification of solid waste, energy content of waste, methods of solid waste disposal, and chemical processing of solid waste. Waste disposal must be performed in situ with energy recovery. Scarcity of available land, pollution problem, and unrecovered latent energy restrict the use of the land-filling method. Pyrolysis is an effective method for the energy recovery and disposal problems. Chemical processing is suitable for the separated cellulosic fraction of the waste material. S.D.

**A79-30207** Study of the characteristics of Ni-Cd storage batteries for space applications (Estudio de las características de las baterías Ni-Cd de utilización espacial). M. Peralta Bellido. *Inta/Conie*, July-Dec. 1978, p. 26-39. 8 refs. In Spanish.

An investigation is conducted of the main characteristics which have to be considered in the selection of nickel-cadmium batteries for space applications, taking into account the results which were obtained in tests in which batteries were kept on board of a satellite in geostationary orbit. Attention is given to the potential of a cell on the basis of free energy considerations, the evolution of heat in a cell, the internal pressure of the sealed cells, and details concerning the experiments in which the cells were in geostationary orbit. The behavior of the various parameters during the tests is illustrated with the aid of a number of graphs and tables. G.R.

**A79-30215** Electrical induction heating of solid fossil fuels in situ - Some estimates. S. T. Fisher (F. T. Fisher's Sons, Ltd., Montreal, Canada). *Speculations in Science and Technology*, vol. 1, Dec. 1978, p. 441-451. 5 refs.

It is believed that the world has adequate reserves of solid fossil fuels to supply it with energy and petrochemicals for centuries. A proposed in-situ technique for high-yield low-cost clean exploitation, electrical induction heating, is described. This method consists of shafts and tunnels encompassing the fuel deposit drilled from the surface, with electrical conductors, forming a coil that may be a kilometer or more in diameter, threaded through these openings. A large alternating current passed through the coil sets up alternating electric and magnetic fields in the solid fossil-fuel deposit. These fields induce currents in the electrically dissipating material. These currents then heat the material so that the energy content of the fuel



can be brought to the surface in the form of gaseous hydrocarbons, steam, or hot gas to be utilized there by conventional methods. This process may double or triple the recovery rates of present solid-fuel extraction methods, at lower cost and with less human and environmental damage than is presently the case. (Author)

**A79-30258** Ga/1-x/Al/x/As-GaAs photovoltaic cells with multilayer structure. S. Panyakeow, J. Shirafuji, and Y. Inuishi (Osaka University, Suita, Japan). *Journal of Physics D - Applied Physics*, vol. 12, Mar. 14, 1979, p. 437-440. 12 refs.

Liquid phase epitaxy was used to fabricate multilayer Ga(1-x)Al(x)As-GaAs heterostructure solar cells. A cell with three layers of Ga(1-x)Al(x)As ( $x = 0.2, 0.13$ , and  $0.07$ ) without antireflection coating gave a much better performance than the one-layer Ga(1-x)Al(x)-GaAs ( $x = 0.2$ ) cell and had a conversion efficiency of 15%. B.J.

**A79-30259** The limiting efficiency of an edge-illuminated multigap solar cell. J. E. Parrott (University of Wales Institute of Science and Technology, Cardiff, Wales). *Journal of Physics D - Applied Physics*, vol. 12, Mar. 14, 1979, p. 441-450. 6 refs.

An edge-illuminated multigap photovoltaic system should show an efficiency greater than that attainable with only a single gap. The theoretical upper limit to the efficiency will occur as the number of different gaps goes to infinity. For this case a detailed balance limit analysis shows that at one sun the predicted efficiency is 64%, increasing with intensity to 81% at 10,000 suns. The effects of stimulated emission are included in the calculations but are found to be negligible. B.J.

**A79-30264 #** Problems in the use of cryogenic pumps in thermonuclear synthesis (Problemy primeneniia kriogenykh nasosov v termoiadernom sinteze). B. V. Glasov, O. S. Druil, V. I. Kurnosov, E. I. Skibenko, L. G. Sorokovoi, Iu. V. Kholod, and V. B. Iufarov (Akademiia Nauk Ukrainskoi SSR, Fiziko-Tekhnicheskii Institut, Kharkov, Ukrainian SSR). *Ukrainskii Fizicheskii Zhurnal*, vol. 24, Jan. 1979, p. 87-93. 20 refs. In Russian.

On the basis of certain design figures for a thermonuclear reactor and assumptions regarding the temperature of the plasma near the pump system, various processes taking place in the vacuum system and the cooling system are studied. It is shown that there are several effects which could contribute simultaneously to an intensification of the desorption of condensate and to the growth of the absolute value of the heat removal. P.T.H.

**A79-30331** Discharge reaction mechanisms in Li/SOCl<sub>2</sub> cells. C. R. Schlaikjer, F. Goebel, and N. Marincic (General Telephone and Electronics Laboratories, Inc., Waltham, Mass.). (Electrochemical Society, Meeting, Atlanta, Ga., Oct. 9-14, 1977.) *Electrochemical Society, Journal*, vol. 126, Apr. 1979, p. 513-522. 40 refs.

Experimental results show that Li/SOCl<sub>2</sub> soluble cathode power sources operating at room temperature do not generate appreciable amounts of lithium sulfur oxyacid salts. SO<sub>2</sub> is produced but at a rate less than that predicted by  $4\text{Li} + 2\text{SOCl}_2 \rightarrow \text{S} + \text{SO}_2 + 4\text{LiCl}$  until near the end of the discharge. The measured number of equivalents per mole of SOCl<sub>2</sub> is near 2. It is possible that SO or an SO polymer is formed during discharge which remains in solution. Cells operating at -20°C produce at least one lithium sulfur oxyacid salt, possibly Li<sub>2</sub>SO<sub>3</sub>, as indicated by chemical analysis of cathodes taken from discharged 2D cells. B.J.

**A79-30332** A lithium/dissolved sulfur battery with an organic electrolyte. R. D. Rau, K. M. Abraham, G. F. Pearson, J. K. Surprenant, and S. B. Brummer (EIC Corp., Newton, Mass.). (Electrochemical Society, Meeting, Philadelphia, Pa., May 8-13, 1977.) *Electrochemical Society, Journal*, vol. 126, Apr. 1979, p. 523-527. 26 refs. Contract No. EY-76-C-02-2520.

The feasibility has been demonstrated of a high energy density Li battery with an Li<sub>2</sub>S positive electrode dissolved in an organic

electrolyte. Virtually 100% of the theoretical capacity could be realized at 50°C at rates below 1.0 mA/sq cm. In high-rate cell configurations 75% cathode utilization is possible at about 4 mA/sq cm. The capacities at high rate are enhanced by Lewis acids, although the ultimate cause of rate limitation is passivation of the current collector by discharge products. Based on the experimental results, a practical energy density of about 300 W-hr/kg is possible using a standard cell design. B.J.

**A79-30333** Steady-state composition profiles in mixed molten salt electrochemical devices. II - Molten carbonate fuel cell analogs. C. E. Vallet and J. Braunstein (Oak Ridge National Laboratory, Oak Ridge, Tenn.). *Electrochemical Society, Journal*, vol. 126, Apr. 1979, p. 527-534. 13 refs. Contract No. W-7405-eng-26.

Steady-state equations, derived previously for composition gradients in battery analogs with binary mixtures of molten salts as electrolytes, have been modified to apply to molten carbonate fuel cells. Since neither of the two like-charged cations of the electrolyte reacts at the electrodes, the concentration gradient arises only from the difference in the mobilities of the two cations. Conditions of current density, electrode separation, electrolyte composition, and temperature that favor either steady state or precipitation of a solid phase are presented in parametric form. Numerical solution of the diffusion-migration equation is used to predict the development with time of the concentration gradient. The computation also simulates the variations with time of emf between anode and cathode both during current flow and during the subsequent decay on open circuit. An electrochemical method for estimation of the interdiffusion coefficient and the ion mobility ratio in a binary electrolyte is outlined. (Author)

**A79-30345** Regulation and control concepts for the possibilities of a utilization of solar energy in the low-temperature range (Regelungstechnische und steuerungstechnische Konzepte für Nutzungsmöglichkeiten der Sonnenenergie im Niedertemperaturbereich). S. Fischer (Aachen Rheinisch-Westfälische Technische Hochschule, Aachen, West Germany). *VDI-Z*, vol. 121, no. 5, Mar. 1979, p. 203-208. 17 refs. In German.

The employment of regulation and control techniques for processes related to the utilization of solar energy in the low-temperature range is considered. It is found that regulation and control concepts in this area do not yet have the importance which they should have in connection with the significance of high-intensity cyclic and stochastic disturbing quantities. The possibilities for a utilization of solar energy are considered and various solar-energy collector types are examined. The direct utilization of solar radiation by means of solar collectors is discussed, taking into account the solar collector as part of the control system and the regulation and control of the solar-energy collector cycle. Aspects concerning the indirect utilization of solar energy by means of air-water-heat pump systems are also explored. Attention is given to the heat pump as part of a control system, an improvement of heat pump control, and the control concept of a heating cycle using a heat pump. G.R.

**A79-30374** Sail power for the world's cargo ships. L. Bergeson. *Technology Review*, vol. 81, Mar.-Apr. 1979, p. 22-36. 8 refs.

The potential of sail power for commercial ships is examined. The 'Preussen' and the 'Thomas W. Lawson' sail vessels, built in 1902, capable of carrying over 8000 long tons of cargo and with a theoretical hull speed of about 22 knots, are described. Recent research on designing advanced sailing ships is considered, noting that sail power is expected to be much more economical than a fossil fuel power plant under selected conditions. A program for conversion to sail power is reviewed, indicating that the first phase includes studies of potential routes where ships up to 2000 deadweight tons would be most competitive. Projected parameters for ship design, rig, cargo handling, and stowage are considered in the light of two prototype vessels, the single hull and the catamaran. Operation of the future



sailing ships is taken into account, and proposals for further research are noted. A.A.

**A79-30391** Mechanism of erosion of metal electrodes of the channel of a MHD generator. I. I. Beilis (Akademiia Nauk SSSR, Institut Vysokikh Temperatur, Moscow, USSR). (*Teplofizika Vysokikh Temperatur*, vol. 16, July-Aug. 1978, p. 848-853.) *High Temperature*, vol. 16, no. 4, Jan. 1979, p. 723-727. 13 refs. Translation.

The erosion of a cathode caused by slowly moving arc spots burning in the combustion products with potassium seeding in the channel of a magnetohydrodynamic (MHD) generator was investigated. On the basis of a numerical analysis of a system of equations for the cathode region of the investigated type of spots it is shown that erosion of the electrode is determined largely by its emission properties and is caused by vaporization of the cathode material. Appropriate processing of the results of experiments conducted on various MHD devices made it possible to establish the presence of a characteristic (for the investigated conditions) value of the work function of a cathode covered with potassium seed. (Author)

**A79-30392** Comparison of results of calculation of flow in an MHD generator with experimental data obtained on the U-25 device. V. A. Bitiurin, V. A. Zhelnin, G. A. Liubimov, and S. A. Medin (Akademiia Nauk SSSR, Institut Vysokikh Temperatur; Moskovskii Gosudarstvennyi Universitet, Moscow, USSR). (*Teplofizika Vysokikh Temperatur*, vol. 16, July-Aug. 1978, p. 854-867.) *High Temperature*, vol. 16, no. 4, Jan. 1979, p. 728-739. 10 refs. Translation.

A method is presented and results given for comparison of a calculation of hydraulic flow with experimental data obtained using the U-25 device. It is shown that the hydraulic model used for calculation permits a completely satisfactory description of plasma flow in a 1D Faraday channel and in framed R and RM channels. As a result of comparing calculation with experiment, values are established for a number of empirical quantities contained in the equations in the hydraulic model. The meaning and range of applicability of the quantities so obtained are discussed, as are possible ways of perfecting the hydraulic model. (Author)

**A79-30484** # Very large vehicles - To be or. W. H. Arata, Jr. (Northrop Corp., Los Angeles, Calif.). *Astronautics and Aeronautics*, vol. 17, Apr. 1979, p. 20-25, 33. 20 refs.

Some of the concepts being studied for large aircraft are briefly discussed. Concepts for conventional takeoff and landing aircraft, distributed-load aircraft, wing-in-ground effect aircraft, multiple fuselages, the laminar-flow-control aircraft, nuclear powered tug, air-cushion-landing-system aircraft, blimp-helicopter combination, and surface-effect ships are mentioned. P.T.H.

**A79-30485** # Large-vehicle concepts. L. W. Noggle (USAF, Aeronautical Systems Div., Wright-Patterson AFB, Ohio) and C. E. Jobe (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio). *Astronautics and Aeronautics*, vol. 17, Apr. 1979, p. 26-32. 18 refs.

The paper briefly surveys most of the very large vehicle concepts examined by Air Force, Navy, NASA, and industry in recent study efforts. Some of these include a conventional aircraft capable of carrying a 400,000-lb load over a range of 6200 n. mi., a laminar flow control aircraft, where slotted wing and tail surfaces provide laminar flow to 70% chord to conserve fuel, nuclear-powered aircraft with active-controls technology, swept-wing space-distributed-load aircraft capable of carrying a million pounds of payload, wing-in-ground-effect vehicles, a power-augmented-ram/wing-in-ground-effect vehicle, and the heavy-lift airship. P.T.H.

**A79-30502** # Measured effects of flow leakage on the performance of the GT-225 automotive gas turbine engine. C. C. Matthews (GM Research Laboratories, Warren, Mich.). *American*

*Society of Mechanical Engineers, Gas Turbine Conference and Exhibit and Solar Energy Conference, San Diego, Calif., Mar. 12-15, 1979, Paper 79-GT-3. 5 p. Members, \$1.50; nonmembers, \$3.00.*

**A79-30505** # The combined reheat gas turbine/steam turbine cycle. I - A critical analysis of the combined reheat gas turbine/steam turbine cycle. I. G. Rice. *American Society of Mechanical Engineers, Gas Turbine Conference and Exhibit and Solar Energy Conference, San Diego, Calif., Mar. 12-15, 1979, Paper 79-GT-7. 7 p. 14 refs. Members, \$1.50; nonmembers, \$3.00.*

**A79-30506** # The combined reheat gas turbine/steam turbine cycle. II - The LM 5000 gas generator applied to the combined reheat gas turbine/steam turbine cycle. I. G. Rice. *American Society of Mechanical Engineers, Gas Turbine Conference and Exhibit and Solar Energy Conference, San Diego, Calif., Mar. 12-15, 1979, Paper 79-GT-8. 8 p. 6 refs. Members, \$1.50; nonmembers, \$3.00.*

**A79-30510** # The application of indirectly fired open cycle gas turbine systems utilizing atmospheric pressure fluidized bed combustors to industrial cogeneration situations. C. L. Marksberry and B. C. Lindahl (Fluidyne Engineering Corp., Minneapolis, Minn.). *American Society of Mechanical Engineers, Gas Turbine Conference and Exhibit and Solar Energy Conference, San Diego, Calif., Mar. 12-15, 1979, Paper 79-GT-16. 10 p. 6 refs. Members, \$1.50; nonmembers, \$3.00.*

**A79-30522** # Conceptual design of a solar powered closed-cycle gas turbine electric power-generation system. T. L. O. Horton, S. C. Kuo, H. T. Shu, and E. R. Fisher (United Technologies Research Center, East Hartford, Conn.). *American Society of Mechanical Engineers, Gas Turbine Conference and Exhibit and Solar Energy Conference, San Diego, Calif., Mar. 12-15, 1979, Paper 79-GT-43. 12 p. 10 refs. Members, \$1.50; nonmembers, \$3.00.* Research sponsored by the U.S. Department of Energy.

The conceptual design characteristics of a closed-cycle gas turbine system suitable for solar electric power generation are presented in this paper. The conceptual designs for both the gas turbine and the heat exchangers required to provide an integrated power conversion system are presented. Technology projected for 1985 availability was utilized in these designs to provide a cost-effective installation in the 1990 time frame. This task was made more credible by the utilization of air rather than helium as the working gas since the vast majority of required technology is well known and available. Also presented are potential power conversion system part-load performance, component layout, and operating characteristics resulting from this conceptual design which allow evaluation of the feasibility of their integration into a total solar plant installation. (Author)

**A79-30530** # Study of integrated gasification combined cycle plant interaction and control. D. J. Ahner, A. S. Patel (General Electric Co., Schenectady, N.Y.), and G. Quentin (Electric Power Research Institute, Palo Alto, Calif.). *American Society of Mechanical Engineers, Gas Turbine Conference and Exhibit and Solar Energy Conference, San Diego, Calif., Mar. 12-15, 1979, Paper 79-GT-60. 9 p. 8 refs. Members, \$1.50; nonmembers, \$3.00.*

This paper discusses the model features and preliminary results of an analytical simulation control study of an integrated gasification combined cycle plant, incorporating air blown, fixed bed gasifiers. The general scope of the study effort and the model capabilities are discussed. In addition, dynamic simulations utilizing various fuel system subloop and station control logic are presented and their implications with respect to power system response and fuel system excursions are described. (Author)

**A79-30532** # Investigation of the heat transfer in cylindrical receiver configurations with inner tubes. K. Bammert, R. Krapp, and P. Seifert (Hannover, Universität, Hannover, West Germany). *American Society of Mechanical Engineers, Gas Turbine Conference and*

*Exhibit and Solar Energy Conference, San Diego, Calif., Mar. 12-15, 1979, Paper 79-GT-64.* 9 p. 11 refs. Members, \$1.50; nonmembers, \$3.00.

The design of a receiver for a closed-cycle gas turbine with air as the working medium is discussed. The emphasis of the investigations is laid upon the optimization of heat transfer to the working medium. The irradiation pattern along the tubes and the effects of the working-medium pressure, the pressure loss and the tube cage geometry are considered. (Author)

**A79-30533 #** Soot and the combined cycle boiler. P. B. Roberts (Solar Turbines International, San Diego, Calif.) and H. D. Marron (U.S. Navy, Naval Ship Engineering Center, Washington, D.C.). *American Society of Mechanical Engineers, Gas Turbine Conference and Exhibit and Solar Energy Conference, San Diego, Calif., Mar. 12-15, 1979, Paper 79-GT-67.* 10 p. 5 refs. Members, \$1.50; nonmembers, \$3.00. Contract No. N0024-77-C-4366.

Liquid-fueled gas turbines can produce serious steam generator fouling in combined cycle applications and other waste heat recovery systems as a result of combustion system generated soot particles. In addition, standard soot blowing particles are not always compatible with the advanced, compact matrix designs sometimes required for minimum package size applications. This paper describes an experimental program conducted on both test rigs and engine hardware designed to evaluate the effects on gas side soot fouling rates of various operational parameters such as soot loading, temperature and velocity. Particular attention is given to the effectiveness of the self-cleaning concept where elevated steam generator metal temperatures are utilized to remove soot deposits. (Author)

**A79-30536 #** Water-cooled gas turbine technology development - Fuels flexibility. M. W. Horner, W. H. Day (General Electric Co., Gas Turbine Div., Schenectady, N.Y.), D. P. Smith (GE Corporate Research and Development Center, Schenectady, N.Y.), and A. Cohn (Electric Power Research Institute, Palo Alto, Calif.). *American Society of Mechanical Engineers, Gas Turbine Conference and Exhibit and Solar Energy Conference, San Diego, Calif., Mar. 12-15, 1979, Paper 79-GT-72.* 15 p. 9 refs. Members, \$1.50; nonmembers, \$3.00.

It is pointed out that water cooling of commercial heavy-duty gas turbine hot section components offers a number of potential advantages over air cooling. Cycle performance will be improved because turbines can be operated at higher firing temperatures and pressure levels and reliability will be increased because of the reduction in component metal temperatures. Heavy or contaminated fuels will be accommodated because cooling holes will be eliminated and because the low surface metal temperatures decrease the corrosion rate and the ash deposition rate. A description is presented of the results obtained from the continuation of a water-cooled gas turbine development program and other related parallel programs. The major concern is with the potential of water-cooled technology for improving turbine tolerance to contaminants in petroleum and coal-derived fuels. G.R.

**A79-30537 #** A multivariable controller for an automotive gas turbine. D. E. Winterbone, N. Munro, and D. J. Nuske (University of Manchester Institute of Science and Technology, Manchester, England). *American Society of Mechanical Engineers, Gas Turbine Conference and Exhibit and Solar Energy Conference, San Diego, Calif., Mar. 12-15, 1979, Paper 79-GT-73.* 14 p. 14 refs. Members, \$1.50; nonmembers, \$3.00.

A complete control system design study is described, starting with a non-linear mathematical model and finishing with the control hardware. The basic objective of the study was to design a controller which reduced the characteristically poor response of the two-shaft automotive gas turbine. This was achieved by identifying the reasons for the acceleration delay and then designing the controller to compensate for them. The gas turbine was simulated by means of a quasi-steady non-linear thermodynamic model implemented on a digital computer. Careful manipulation of the equations enabled the model to run in real-time. This model was linearized at various

operating points and the transfer functions obtained were compared with those measured on the plant. The control system was designed using Rosenbrock's multivariable inverse Nyquist array technique. These compensators were grafted onto the original single loop control box and fitted to the engine. The results obtained on the engine test bed are compared with those using the original controller. A very large reduction in response lag is obtained with the multivariable control system. (Author)

**A79-30539 #** A flywheel energy storage and conversion system for solar photovoltaic applications. A. R. Millner (MIT, Lexington, Mass.). *American Society of Mechanical Engineers, Gas Turbine Conference and Exhibit and Solar Energy Conference, San Diego, Calif., Mar. 12-15, 1979, Paper 79-Sol-1.* 10 p. Members, \$1.50; nonmembers, \$3.00. Research sponsored by the U.S. Department of Energy.

A low-drag, low-power magnetic bearing and a permanent magnet brushless d-c motor-generator have been developed for a satellite flywheel. These will be combined with a terrestrial flywheel and control electronics to make up a flywheel energy storage and conversion system for use in a stand-alone solar photovoltaic residence. Technical and economic performance analyses indicate that, contrary to general thought, a flywheel system will be competitive if not superior to more conventional systems utilizing either present-day or advanced batteries. This derives from the ability of the flywheel to perform the functions of d-c to a-c inversion and optimal impedance matching between the PV arrays and the load in addition to providing energy storage. The motor-generator design will also be discussed. This paper describes the structural topology, performance data, design parameters, and test measurements of the magnetic bearing and motor-generator as well as a description of the flywheel and control electronics to be used. A preliminary discussion of the economic aspects is also included. (Author)

**A79-30540 #** Design considerations of small solar collector systems using plane heliostats. K. J. Waldron, A. C. Meyers (Houston, University, Houston, Tex.), and K. Kheyrandish. *American Society of Mechanical Engineers, Gas Turbine Conference and Exhibit and Solar Energy Conference, San Diego, Calif., Mar. 12-15, 1979, Paper 79-Sol-2.* 10 p. 8 refs. Members, \$1.50; nonmembers, \$3.00.

The primary advantage of the central receiver concept is the minimization of heat transmission in the form of enthalpy of a working fluid. This is replaced by efficient and low cost optical energy transmission. This characteristic renders collectors using heliostats to reflect solar radiation onto a stationary receiver attractive for small to medium scale, as well as large scale collection. This paper describes several years of design studies and simulations of central receiver systems scaled to be suitable for heating and cooling of commercial buildings or for some industrial process heat applications. The relatively small distances between the heliostats and receiver, vertical flat plate receiver geometry, and relatively low receiver result in optical simulation characteristics of such systems quite different to those of the large solar tower systems. The variation in radiation intensity over the surface of the receiver due to the relatively irregular shape of the insolated patch from a heliostat segment, and due to dispersion produced by off axis aberration in segmented heliostats, requires several unique features in the receiver design. (Author)

**A79-30541 #** Solar Rankine engines - Examples and projected costs. R. E. Barber (Barber-Nichols Engineering Co., Arvada, Colo.). *American Society of Mechanical Engineers, Gas Turbine Conference and Exhibit and Solar Energy Conference, San Diego, Calif., Mar. 12-15, 1979, Paper 79-Sol-3.* 10 p. 8 refs. Members, \$1.50; nonmembers, \$3.00.

The Organic Rankine Cycle Engine (ORCE) for converting solar heat into shaft power is discussed. The efficiency of the system varies from 7-8% for an ORCE heated by low temperature (200 F) flat plate collectors to 25% with high temperature concentrating collectors (300 F). The first solar heated ORCE, built in 1973, produced 3 tons of air conditioning, with the cycle efficiency based on the shaft

power into the generator estimated at about 7.5%. ORCEs developed for irrigation applications include a 50 hp unit located in Gilla Bend, Arizona, and a 25 hp unit located in Willard, New Mexico, with a design point cycle efficiency at 15%. The current \$150 to \$200 m sq cost of concentrating collectors is estimated to lead to a system cost of over \$2500/kw peak. A.A.

**A79-30542 #** Review of liquid piston pumps and their operation with solar energy. C. L. Murphy (McGill University, Montreal, Canada). *American Society of Mechanical Engineers, Gas Turbine Conference and Exhibit and Solar Energy Conference, San Diego, Calif., Mar. 12-15, 1979, Paper 79-Sol-4*. 8 p. 10 refs. Members, \$1.50; nonmembers, \$3.00.

Liquid piston pumps are considered to be systems involving the up and down oscillations of a fluid column contained in a vessel which is enclosed at the top. At the bottom a suitable arrangement of check valves converts the oscillatory motion to a pumping action. The oscillations may be generated by cyclic heating, inertia forces, or combinations of the two. Existing designs of LPP's are reviewed. Experimental results and a theoretical analysis are given for a straight tube LPP. The design of a solar LPP is presented, which appears to be a practical and simple means of converting heat energy from a solar panel to potential energy of a water reservoir. (Author)

**A79-30543 \* #** Do photovoltaics have a future. B. F. Williams (RCA Laboratories, Princeton, N.J.). *American Society of Mechanical Engineers, Gas Turbine Conference and Exhibit and Solar Energy Conference, San Diego, Calif., Mar. 12-15, 1979, Paper 79-Sol-7*. 3 p. 9 refs. Members, \$1.50; nonmembers, \$3.00. Research supported by the RCA Laboratories; Contracts No. E(04-3)-1286; No. JPL-954352.

There is major concern as to the economic practicality of widespread terrestrial use because of the high cost of the photovoltaic arrays themselves. Based on their high efficiency, photovoltaic collectors should be one of the cheapest forms of energy generators known. Present photovoltaic panels are violating the trend of lower costs with increasing efficiency due to their reliance on expensive materials. A medium technology solution should provide electricity competitive with the existing medium to high technology energy generators such as oil, coal, gas, and nuclear fission thermal plants. Programs to reduce the cost of silicon and develop reliable thin film materials have a realistic chance of producing cost effective photovoltaic panels. G.R.

**A79-30544 #** Photovoltaic concentrator system technology and applications experiments. E. L. Burgess (Sandia Laboratories, Albuquerque, N. Mex.). *American Society of Mechanical Engineers, Gas Turbine Conference and Exhibit and Solar Energy Conference, San Diego, Calif., Mar. 12-15, 1979, Paper 79-Sol-9*. 11 p. 17 refs. Members, \$1.50; nonmembers, \$3.00. Research supported by the U.S. Department of Energy.

In a flat-panel photovoltaic array a significant portion of the array cost is due to the solar cell cost. The use of concentrated sunlight can increase the output of solar cells and reduce the total cell area required for a given array output. Thus, the concentrator approach is to trade expensive cell area for what is, hopefully, less expensive concentrating optics area. Aspects of photovoltaic concentrator technology development are examined, taking into account silicon solar cells, gallium arsenide solar cells, multi-bandgap solar cells, the adaptation of solar thermal technology, conventional optical designs, and advanced concepts. Photovoltaic concentrator applications experiments are also discussed. G.R.

**A79-30545 #** Field tests of photovoltaic power systems. M. D. Pope and R. W. Matlin (MIT, Lexington, Mass.). *American Society of Mechanical Engineers, Gas Turbine Conference and Exhibit and Solar Energy Conference, San Diego, Calif., Mar. 12-15, 1979, Paper 79-Sol-10*. 11 p. 21 refs. Members, \$1.50; nonmembers, \$3.00. Research sponsored by the U.S. Department of Energy.

Field test experience gained at existing photovoltaic test sites is discussed. These sites include a 25-kW peak power system at Mead,

Nebraska, a 12-kW peak array at MIT/Lincoln Laboratory, a 1.5-kW peak PV power system at the Chicago Museum of Science and Industry, and several small (about 100 watts peak) arrays located in various urban and rural sites. Data are given on failures which have occurred in the field and on the frequency of unscheduled outages. Also, information is presented concerning the environmental extremes to which the systems have been exposed. Operating experience gained from these projects is discussed in the contexts of storage, reliability, safety and cost. Finally, some projects which are currently in the design stage are discussed. (Author)

**A79-30546 #** Solar photovoltaic power for residential use. B. Hammond (Motorola, Inc., Phoenix, Ariz.). *American Society of Mechanical Engineers, Gas Turbine Conference and Exhibit and Solar Energy Conference, San Diego, Calif., Mar. 12-15, 1979, Paper 79-Sol-11*. 8 p. Members, \$1.50; nonmembers, \$3.00.

A cost analysis is conducted concerning the prospects of solar photovoltaic power for residential use. When photovoltaics reach 50 cents/Wp, they will become competitive with utility power, if utility power is available as a backup. Without utility backup, cost per kWh is approximately one to three times the cost of grid power. As the cost of modules decrease, the balance of system costs become very significant. In particular, voltage regulator, inverter, batteries, and motor generator become a large percentage of the total. The inverter could be eliminated if dc equipment were used. The use of dc equipment, however, will result in higher maintenance costs than ac equipment. Conventional batteries will continue to increase in price about 10% per year. Possibly more economical means of storage will be available by 1989. If so, then the generator could be replaced with additional energy storage. G.R.

**A79-30547 #** An overview of photovoltaic power systems. C. E. Backus (Arizona State University, Tempe, Ariz.). *American Society of Mechanical Engineers, Gas Turbine Conference and Exhibit and Solar Energy Conference, San Diego, Calif., Mar. 12-15, 1979, Paper 79-Sol-12*. 9 p. 48 refs. Members, \$1.50; nonmembers, \$3.00.

Photovoltaic power systems are presently being used for a large number of remote or rural applications. These power systems are replacing conventional power sources such as diesel gasoline generators or primary batteries. With the present high cost of solar cells the photovoltaic power system costs are completely dominated by the cost of the solar cell arrays. Since none of the other system components present major problems to low cost systems, essentially all of the U.S. photovoltaic program is directed towards achieving low cost solar cell panels or systems. The three approaches which are being pursued to lower the cost of photovoltaic systems include the production of low cost silicon solar cell arrays, the development of new materials that would lend themselves to low cost, thin-film arrays, and the development of photovoltaic concentration systems. G.R.

**A79-30548 #** Unique aspects of terrestrial photovoltaic system design. Z. C. Putney (Solarex Corp., Rockville, Md.). *American Society of Mechanical Engineers, Gas Turbine Conference and Exhibit and Solar Energy Conference, San Diego, Calif., Mar. 12-15, 1979, Paper 79-Sol-14*. 5 p. Members, \$1.50; nonmembers, \$3.00.

The design of terrestrial photovoltaic power systems involves a process of optimization of elements quite different from that employed in conventional power sources. Solar input varies locally and temporally. Efficiency of conversion to electricity is highly dependent upon collector concentration ratio, orientation and tracking capability, and optical and solar cell technologies employed; other variations occur with temperature and changes in reflective and transmissive properties of components. Reliability is dependent upon system complexity and hardware selected. Energy storage needs are a dual function of the fluctuating solar input and load profile, with a substantial range of photovoltaic array size/storage tradeoffs available in designing a stand-alone system. Key aspects to be considered in the design of a photovoltaic power system are discussed in this

paper, with a specific application treated in details as an example of their implementation. (Author)

**A79-30549 #** Low cost thin-film CdS-based solar cells progress and promise. A. M. Barnett and J. D. Meakin (Delaware, University, Newark, Del.). *American Society of Mechanical Engineers, Gas Turbine Conference and Exhibit and Solar Energy Conference, San Diego, Calif., Mar. 12-15, 1979, Paper 79-Sol-15*. 10 p. 12 refs. Members, \$1.50; nonmembers, \$3.00.

The application of loss minimization techniques to specific designs of CdS/Cu<sub>2</sub>S thin film photovoltaic solar cells has successfully identified those areas where design changes and the development of new fabrication techniques can lead to improvement in energy conversion efficiency. The successful development of novel fabrication technology has led to the reproducible improvement in direct sunlight, from an original level of 6.8% achieved in December 1975 to 9.15% presently reported. Further application of this loss minimization technique indicates that significant improvements in open-circuit voltage as well as continued improvements in current and fill factor can lead to the development of a CdS/Cu<sub>2</sub>S thin film solar cell with an energy conversion efficiency in excess of 10%. This 10% efficiency should be achieved within one year. -G.R.

**A79-30550 #** Cast semicrystalline silicon for solar cells. Z. C. Putney (Solarex Corp., Rockville, Md.). *American Society of Mechanical Engineers, Gas Turbine Conference and Exhibit and Solar Energy Conference, San Diego, Calif., Mar. 12-15, 1979, Paper 79-Sol-16*. 5 p. 5 refs. Members, \$1.50; nonmembers, \$3.00.

The widespread use of photovoltaics for the generation of electric power depends partly on the availability of low-cost materials for the manufacture of solar cells. One of several solutions proposed for obtaining such a material is concerned with the casting of semicrystalline ingots. It has been demonstrated that cast semicrystalline silicon can be used to produce high efficiency solar cells. Work is now continuing on understanding the characteristics of the inherent grain boundaries, and increasing the already high level of insensitivity to impurities. Upscaling for commercial production is underway, which should prove semicrystalline silicon to be a major source of base material for the solar cell industry within the next two years. -G.R.

**A79-30551 \* #** Structural cost optimization of photovoltaic central power station modules and support structure. P. D. Sutton (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.), W. J. Stolte, and R. O. Marsh (Bechtel National, Inc., San Francisco, Calif.). *American Society of Mechanical Engineers, Gas Turbine Conference and Exhibit and Solar Energy Conference, San Diego, Calif., Mar. 12-15, 1979, Paper 79-SOL-17*. 8 p. Members, \$1.50; nonmembers, \$3.00. Research sponsored by the U.S. Department of Energy.

The results of a comprehensive study of photovoltaic module structural support concepts for photovoltaic central power stations and their associated costs are presented. The objective of the study has been the identification of structural cost drivers. Parametric structural design and cost analyses of complete array systems consisting of modules, primary support structures, and foundations were performed. Area related module cost was found to be constant with design, size, and loading. A curved glass module concept was evaluated and found to have the potential to significantly reduce panel structural costs. Conclusions of the study are: array costs do not vary greatly among the designs evaluated; panel and array costs are strongly dependent on design loading; and the best support configuration is load dependent. (Author)

**A79-30552 #** Photovoltaic electric power generation from a utility perspective. F. R. Goodman, Jr. (Los Angeles Department of Water and Power, Los Angeles, Calif.). *American Society of Mechanical Engineers, Gas Turbine Conference and Exhibit and Solar Energy Conference, San Diego, Calif., Mar. 12-15, 1979, Paper 79-Sol-18*. 8 p. Members, \$1.50; nonmembers, \$3.00.

The existing technology for photovoltaic energy conversion is described, and the prospects for improving the technology so that photovoltaic conversion becomes viable for utility related applications are discussed. Photovoltaic devices and photovoltaic systems are considered, as are the relevant technical and institutional issues. The integration of large-scale photovoltaic systems into an electric utility's generating mix is taken into account, together with an examination of system reliability and effective capacity. It is concluded that photovoltaic conversion is highly amenable to usage in dispersed generation throughout an urban utility's service territory with minimal aesthetic or other impact on the environment. A.A.

**A79-30554 \* #** Benefits of solar/fossil hybrid gas turbine systems. H. S. Bloomfield (NASA, Lewis Research Center, Cleveland, Ohio). *American Society of Mechanical Engineers, Gas Turbine Conference and Exhibit and Solar Energy Conference, San Diego, Calif., Mar. 12-15, 1979, Paper 79-GT-38*. 16 p.

The potential benefits of solar/fossil hybrid gas turbine power systems were assessed. Both retrofit and new systems were considered from the aspects of cost of electricity, fuel conservation, operational mode, technology requirements, and fuels flexibility. Hybrid retrofit (repowering) of existing combustion (simple Brayton cycle) turbines can provide near-term fuel savings and solar experience, while new and advanced recuperated or combined cycle systems may be an attractive fuel saving and economically competitive vehicle to transition from today's gas and oil-fired powerplants to other more abundant fuels. (Author)

**A79-30555 \* #** High-freezing-point fuels used for aviation turbine engines. R. Friedman (NASA, Lewis Research Center, Cleveland, Ohio). *American Society of Mechanical Engineers, Gas Turbine Conference and Exhibit and Solar Energy Conference, San Diego, Calif., Mar. 12-15, 1979, Paper 79-GT-141*. 12 p. 21 refs.

Broadened-specification aviation fuels could be produced from a greater fraction of crude source material with improvements in fuel supply and price. These fuels, particularly those with increased final boiling temperatures, would have higher freezing temperatures than current aviation turbine fuels. The higher-freezing-point fuels can be substituted in the majority of present commercial flights, since temperature data indicate that in-flight fuel temperatures are relatively mild. For the small but significant fraction of commercial flights, where low fuel temperatures make higher freezing-point fuel use unacceptable, adaptations to the fuel or fuel system may be made to accommodate this fuel. Several techniques are discussed. Fuel heating is the most promising concept. One simple system design uses existing heat rejection from the fuel-lubricating oil cooler, another uses an engine-driven generator for electrical heating. Both systems offer advantages that outweigh the obvious penalties. (Author)

**A79-30595** Chemical studies of stack fly ash from a coal-fired power plant. D. G. Coles, R. C. Ragaini, J. M. Ondov (California, University, Livermore, Calif.), G. L. Fisher, D. Silberman, and B. A. Prentice (California, University, Davis, Calif.). *Environmental Science and Technology*, vol. 13, Apr. 1979, p. 455-459. 40 refs. Contract No. W-7405-eng-48.

Concentrations of 42 minor and trace elements in four size fractions of stack fly ash from a large Western coal-fired power plant are reported, together with a discussion of their geochemical behavior. Twenty-two elements, including Al, Ca, Ce, Tb, Sc, and Ti, showed little or no enrichment on the smaller fly-ash particles, while in As, Cd, Ga, Mo, Pb, Sb, Se, W, and Zn the enrichment fraction was observed to increase with decreasing particle size. The behavior of the rest (Ba, Be, Co, Cr, Cu, Ni, Sr, U, and V) was found to be intermediate to that of elements in the groups I and II. A.A.

**A79-30599 #** Electromechanical conversion of energy during the deceleration of a piston in a uniform magnetic field (Elektromekhanicheskoe preobrazovanie energii pri tormozhenii provodiaschego porshnia v odnorodnom magnitnom pole). V. T. Chemeris and A. D. Podol'tsev (Akademiia Nauk Ukrainskoi SSR, Institut Elektrodinamiki, Kiev, Ukrainian SSR). *Problemy Tekh-*

*nicheskoi Elektrodinamiki*, no. 67, 1978, p. 108-114. 5 refs. In Russian.

In the present paper, the characteristics of electromechanical energy conversion during impulsive electrodynamic braking of a massive electrically conducting piston in a uniform external magnetic field are analyzed under the assumption of inductive power takeoff to the external resistance or induction circuit. The braking efficiency is assessed, and means of increasing the coefficient of kinetic to electromagnetic energy conversion are discussed. V.P.

**A79-30742** Effects of nonlinear decay of backscattered light on the anomalous reflectivity. S. J. Karttunen and R. R. E. Salomaa (Technical Research Centre of Finland, Esbo, Finland). *Plasma Physics*, vol. 21, Mar. 1979, p.247-255. 24 refs.

The effects of parametric decay of backscattered light on the anomalous reflectivity caused by stimulated Raman or Brillouin scattering are investigated. The model takes into account five waves: the pump, the backscattered wave and its electromagnetic decay mode, and two electrostatic plasma waves propagating in opposite directions. Two threshold intensities are predicted: above the lower one the parametric generation starts as a three-wave process; once the pump intensity exceeds the secondary threshold the backscattered wave experiences the nonlinear damping and the reflectivity decreases. The reflectivity reaches a saturation value of the reciprocal of the golden mean, about 62%. The total reflection coefficient of the plasma has a maximum value of 65-78% at 7-9 times the instability threshold, depending on the electrostatic noise level. P.T.H.

**A79-30910** Thermodynamics of the conversion of diluted radiation. P. T. Landsberg and G. Tonge (Southampton, University, Southampton, England). *Journal of Physics A - Mathematical and General*, vol. 12, Apr. 1979, p. 551-562. 13 refs.

The thermodynamically permitted efficiencies of solar energy conversion are estimated for conversion into work of direct and of diffuse radiation, and of a combination of the two. An 'effective temperature' is introduced into the analysis, the equality of which for the sink and all pumps defines in part an effective equilibrium, a condition which implies that no work can be extracted from the system. Maximum conversion efficiency as a function of the degree of dilution of the radiation in the absorber is calculated and plotted. For a black absorber, the maximum efficiency rises to 0.93 as the radiation becomes more direct. For a gray absorber, the efficiency can range from 60 to 83%. P.T.H.

**A79-30952 #** Solar energy via satellites and international cooperation (Energie solaire via satellites et coopération internationale). J.-L. Magdelénat (McGill University, Montreal, Canada). In: *Annals of air and space law*. Volume 3. Toronto, Carswell Co., Ltd.; Paris, Editions A. Pedone, 1978, p. 467-482. 41 refs. In French.

International public law and certain provisions of space law are needed to resolve legal questions arising from the development and operation of satellite systems producing solar energy. The Satellite Sun Power Station and the ERDA Powersat project are among the systems under consideration. Attention is given to conflicts over the use of the geostationary orbit, and to the concept that technological capability gives a nation the de facto right to put that technology into effect. J.M.B.

**A79-30996** Gasification of raw lignite in the tube-furnace gasifier (Vergasung von Rohbraunkohle im Röhrenofen-Vergaser). F. H. Franke, K.-J. Klöcker, W. Koch (Rheinische Braunkohlenwerke AG, Cologne, West Germany), and H. Kreusing (Aachen, Rheinisch-Westfälische Technische Hochschule, Aachen, West Germany). *Brennstoff-Wärme-Kraft*, vol. 31, Mar. 1979, p. 85-89. In German. Research supported by the Bundesministerium für Forschung und Technologie.

The viability of the tube-furnace gasifier process is explored. Experimental studies at RWTH-Aachen's technical facilities are

considered, together with a description of the results. The advantages expected from the process in the production of SNG are compared with those of conventional gasifying processes, showing no decisive advantages for the tube-furnace gasifier. A.A.

**A79-30997** Uncoupling of economic growth and energy consumption - A new strategy of energy politics or only a new slogan ('Entkopplung' von Wirtschaftswachstum und Energieverbrauch - Eine neue Strategie der Energiepolitik oder nur ein neues Schlagwort). M. Horn. *Energiewirtschaftliche Tagesfragen*, vol. 29, Mar. 1979, p. 144-152. 24 refs. In German.

The term 'uncoupling', which has been used by Müller and Stoy (1978) in their study regarding an economic growth without the consumption of additional energy, appears to indicate a certain quasi-mechanical relation between economic growth and energy consumption which can somehow be abolished in the future. The reported investigation shows, however, that the relation between economic growth and energy consumption is considerably more complex and is also significantly more variable than the concept 'uncoupling' would suggest. Attention is given to the methods used for predicting energy consumption, decision predictions with given rates of growth, the factors which determine the energy requirements, and the relation between economic growth and energy consumption according to the result of official energy prognoses. G.R.

**A79-30998** The economics of electric power generation from wind energy (Wirtschaftlichkeit der Stromerzeugung aus Windenergie). W. Former and H.-H. Nissen. *Energiewirtschaftliche Tagesfragen*, vol. 29, Mar. 1979, p. 161-166. 7 refs. In German. Research supported by the Bundesministerium für Forschung und Technologie.

A description is presented of the approaches which must be employed in an evaluation of the economic feasibility of utilization of wind energy for electric power generation applications. The assumption is often made that wind in connection with its intermittent nature cannot provide a contribution to the energy supply whose availability can be considered as assured. In such a case an economic operation of wind energy installations is only possible if the annual capital costs of the wind energy systems are less than the annual fuel costs of the thermal power stations which have been replaced by the wind energy installations. Attention is also given to questions regarding a possible contribution of wind energy to the assured power supply and the economical implications of such a contribution. G.R.

**A79-30999** Production of mechanical energy by thermodynamic conversion of solar energy (Production d'énergie mécanique par la conversion thermodynamique de l'énergie solaire). F. Pharoabod and X. Pouget-Abadie (Electricité de France, Paris, France). (*Société Française des Mécaniciens, Conférence, Paris, France, Dec. 6, 1977.*) *Revue Française de Mécanique*, no. 66, 1978, p. 5-16. In French.

After a review is presented of the basic principles of thermodynamic conversion of solar energy, in which the ideas of the efficiency curve and the isoefficiency curves for determining optimal temperature are discussed, the paper describes several existing engineering projects. These are a pumping system for arid zones, a 300 kWe power plant, and a planned 2000 kW solar power plant using a field of 300 heliostats. P.T.H.

**A79-31000** Thermal energy storage (Le stockage thermique de l'énergie). M. Coeytaux (Société Caliqua, Paris, France). (*Société Française des Mécaniciens, Conférence, Paris, France, Dec. 6, 1977.*) *Revue Française de Mécanique*, no. 66, 1978, p. 17-19. In French.

The range of materials that can be used for solar energy storage is very large, and the material to be selected depends on the temperature level and type of storage planned. For storage of sensible heat there are available pressurized water, organic fluids, fused salts, liquid metals, and refractory solids. For storage of latent heat there are nitrates, carbonates, sulfates, chlorides, and fluorides. P.T.H.

**A79-31001** ICEC 7; Proceedings of the Seventh International Cryogenic Engineering Conference, London, England, July 4-7, 1978. Conference sponsored by Air Products, Ltd., BOC, Ltd., British Gas Corp., Central Electricity Generating Board, et al. Guildford, Surrey, England, IPC Science and Technology Press, Ltd. (International Cryogenic Engineering Conferences. Volume 7), 1978. 747 p. \$85.80.

The employment of cryogenics in space research is considered along with superconducting magnets, cryostats and systems, superfluid helium, cryogenics in electrical engineering, industrial applications, heat transfer in the rotating frame, refrigeration, biological freezing, flow dynamics, materials properties, heat transfer, superconducting materials preparation, instrumentation, superconducting conductors, and cryogenic technology and superconductivity in controlled fusion. Attention is given to modern problems of stabilization of superconducting systems, laboratory scale superconducting magnets incorporating filamentary niobium tin, superconductivity in electricity supply, and Soviet investigations on pool boiling of cryogenic liquids. G.R.

**A79-31003** Cryogenic technology and superconductivity in controlled fusion. N. A. Chernoplekov, D. P. Ivanov, V. E. Keilin, D. A. Panov, and I. L. Zotov (Akademiia Nauk SSSR, Institut Atomnoi Energii, Moscow, USSR). In: ICEC 7; Proceedings of the Seventh International Cryogenic Engineering Conference, London, England, July 4-7, 1978. Guildford, Surrey, England, IPC Science and Technology Press, Ltd., 1978, p. 18-34. 22 refs.

The main trends are discussed regarding research and development work conducted in the area of controlled thermonuclear reaction. One of the key problems in controlled thermonuclear reactions (CTR) is related to the creation of very intense magnetic fields. Developments concerning plasma magnetic confinement systems are considered, taking into account the design of superconducting magnetic systems. It is shown that cryogenics offers also possibilities for solving problems related to fuel production and energy utilization in CTR systems. Attention is given to techniques of refrigeration, the influence of mechanical loads, and the effect of radiation. G.R.

**A79-31008** Superconductivity in antenna engineering. V. A. Pavliuk, E. F. Krivosheev, M. A. Martynov, V. I. Mikhailov, and M. P. Chetaev (Akademiia Nauk Ukrainskoi SSR, Fiziko-Tekhnicheskii Institut Nizkikh Temperatur, Kharkov, Ukrainian SSR). In: ICEC 7; Proceedings of the Seventh International Cryogenic Engineering Conference, London, England, July 4-7, 1978. Guildford, Surrey, England, IPC Science and Technology Press, Ltd., 1978, p. 63-68. 8 refs.

A description is presented of advances in antenna engineering which are based on a utilization of the characteristics of superconductivity. New approaches for an optimization of small-size antenna devices are related to an employment of the physical properties of material maintained at low temperatures. Deep cooling with the aid of appropriate cryogenic supply systems appears to provide the only feasible method for a qualitative improvement of the parameters of small-size antennas. G.R.

**A79-31009** Superconducting magnets - Present status and problems. G. Bronca (Commissariat à l'Energie Atomique, Paris, France). In: ICEC 7; Proceedings of the Seventh International Cryogenic Engineering Conference, London, England, July 4-7, 1978. Guildford, Surrey, England, IPC Science and Technology Press, Ltd., 1978, p. 69-74.

A number of superconducting magnets have been in use for many years now. It has, therefore, been demonstrated that superconducting magnets can be employed efficiently and reliably. However, the number of applications is still not increasing very rapidly. The various applications of superconducting magnets are examined. Attention is given to accelerators and storage rings, bending and focusing elements, large magnets, detectors, high-intensity field magnets, and applications as optical lens components. G.R.

**A79-31014** Design and development of the US-TESPE toroidal coil. M. O. Hoenig (MIT, Cambridge, Mass.). In: ICEC 7; Proceedings of the Seventh International Cryogenic Engineering Conference, London, England, July 4-7, 1978. Guildford, Surrey, England, IPC Science and Technology Press, Ltd., 1978, p. 156-170. Research sponsored by the U.S. Department of Energy.

The TESPE facility at Karlsruhe in West Germany, is a small compact torus. It consists of six superconducting toroidal coils and includes poloidal field simulation. One of the six TESPE coils is to be replaced with a U.S. built test coil, called US-TESPE. The (German) TESPE toroidal coils are cooled by a stream of liquid helium from a ring cryostat surrounding the toroidal coils. Each coil has its own vacuum tight housing and is surrounded by a vacuum. The superconductor used in the (German) TESPE coils is NbTi. The coils will be operated at 7000 A, will provide an overall current density of 7000 A/sq cm and a maximum environmental field of 7 tesla. The US-TESPE coil is being developed using a Nb3Sn force cooled superconducting cable. G.R.

**A79-31019** Refrigeration requirements for future superconductive energy related applications. S. W. Van Sciver, M. A. Hilal, G. E. McIntosh, and E. L. Stone (Wisconsin, University, Madison, Wis.). In: ICEC 7; Proceedings of the Seventh International Cryogenic Engineering Conference, London, England, July 4-7, 1978. Guildford, Surrey, England, IPC Science and Technology Press, Ltd., 1978, p. 296-309. 34 refs.

A survey of the refrigeration needs of proposed superconductive energy related technologies is presented. The devices which are considered include: superconductive magnetic energy storage, magnetically confined fusion reactors, superconducting power transmission lines, magnetohydrodynamic units, and superconducting turbine generators. For each system, the cryogenic helium inventory, makeup and refrigeration requirement are discussed. The survey consists of a compilation of estimates from existing system studies and private communications with various workers in the field. A comparison between future and current state-of-the-art refrigeration is included. (Author)

**A79-31020** The utilization of LH2 and LNG cold for generation of electric power by a cryogenic-type Stirling engine. K. Oshima, Y. Ishizaki, S. Kamiyama, M. Akiyama (Tokyo, University, Tokyo, Japan), and M. Okuda (Tokyo Gas Co., Ltd., Tokyo, Japan). In: ICEC 7; Proceedings of the Seventh International Cryogenic Engineering Conference, London, England, July 4-7, 1978.

Guildford, Surrey, England, IPC Science and Technology Press, Ltd., 1978, p. 310-317. 6 refs. Research supported by the Iwatani Naoji Foundation.

In a regasification process for LNG and LH2, a cryogenic-type Stirling engine combined with an electric generator is used as the main component. This engine is cooled by LNG or LH2 and is heated by hot water rejected from the power station, so that the engine runs and supplies additional electric power together with fuel gas supplied at room temperature. A regasification process supplying LH2 and LNG for a 1,000 MW power station has been designed. Results of a successful test made on a small cryogenic-type Stirling engine are described. (Author)

**A79-31086** Direct conversion of solar energy into laser radiation. A. L. Golger, L. I. Gudzenko, and S. I. Iakovlenko (Akademiia Nauk SSSR, Fizicheskii Institut and Nauchno-Issledovatel'skii Institut Vysokikh Temperatur, Moscow, USSR). (Kvantovaya Elektronika /Moscow/, vol. 5, Sept. 1978, p. 1982-1989.) Soviet Journal of Quantum Electronics, vol. 8, Sept. 1978, p. 1118-1122. 14 refs. Translation.

The possibility of converting solar energy into laser radiation is

discussed for a mixture of xenon and cesium vapor as the active medium. Estimates show that using a 20-fold solar radiation concentrator it should be possible to achieve CS stimulated emission at 1358.9 and 1469.5 nm with a conversion efficiency of about 3.5%. For an active medium about 25 m long and having a transverse cross section of about  $0.4 \times 0.1$  m, the laser power will be about 7 kW. (Author)

**A79-31098 Thermoelectric magnetohydrodynamics.** J. A. Shercliff (Warwick, University, Coventry, England). *Journal of Fluid Mechanics*, vol. 91, Mar. 23, 1979, p. 231-251. 25 refs.

The reported investigation is concerned with the establishment of the equations of magnetohydrodynamics and thermal convection when coupled by thermoelectricity. Some illustrative problems in which the thermal field is known ab initio are solved. Examples where the effects are due to either continuous or discontinuous variation of material composition are included. Practical magnitudes are discussed for the case of a fusion-reactor blanket, where the effects are potentially important owing to the unusual thermoelectric power of lithium. G.R.

**A79-31099 Two-dimensional analyses related to wave-energy extraction by submerged resonant ducts.** J. Lighthill (Cambridge University, Cambridge, England). *Journal of Fluid Mechanics*, vol. 91, Mar. 23, 1979, p. 253-317. 14 refs.

It is pointed out that submerged resonant ducts offer an approach to the design of wave-energy extraction devices consistent with the need for maximum seaworthiness. A full account is provided of one type of analysis of these systems, based upon two-dimensional wave hydrodynamics and linearized duct dynamics. One theoretical prediction is that the effective pressure fluctuations to which a resonant duct responds can be substantially greater than those that would be present at the level of the duct mouth if the duct were absent. Other important predictions are concerned with added mass, radiation damping, and the conditions for optimum energy extraction. G.R.

**A79-31121 \* # Advanced air transport concepts.** J. K. Mollon (NASA, Langley Research Center, Aeronautical System Div., Hampton, Va.). *AIAA Student Journal*, vol. 17, Spring 1979, p. 12-16. 6 refs.

The concepts of laminar flow control, very large all-wing aircraft, an aerial relay transportation system and alternative fuels, which would enable large improvements in fuel conservation in air transportation in the 1990's are discussed. Laminar boundary layer control through suction would greatly reduce skin friction and has been reported to reduce fuel consumption by up to 29%. Distributed load aircraft, in which all fuel and payload are carried in the wing and the fuselage is absent, permit the use of lighter construction materials and the elimination of fuselage and tail drag. Spanloader aircraft with laminar flow control could be used in an aerial relay transportation system which would employ a network of continuously flying liners supplied with fuel, cargo and crews by smaller feeder aircraft. Liquid hydrogen and methane fuels derived from coal are shown to be more weight efficient and less costly than coal-derived synthetic jet fuels. A.L.W.

**A79-31146 # Biological conversion of solar energy (Biologicheskoe preobrazovanie solnechnoi energii).** A. A. Krasnovskii. *Akademiia Nauk SSSR, Vestnik*, no. 1, 1979, p. 83-96. 17 refs. In Russian.

Some topics on biological conversion of solar energy are touched upon, including the molecular mechanism of photosynthesis, the photochemistry of chlorophyll, the mechanism of photosynthesis of hydrogen by water organism cells, and the transfer of electrons in reactions centers of photosynthesizing bacteria. It is pointed out that the limiting efficiency of photosynthesis processes is 15%, while silicon solar batteries in spacecraft can use up to 20% of the solar radiation. P.T.H.

**A79-31153 A new thermochemical process for hydrogen production.** B. Lecart, M. Devalette, J. P. Manaud, G. Meunier, and P. Hagenmuller (CNRS, Laboratoire de Chimie du Solide, Talence, Gironde, France). *International Journal of Hydrogen Energy*, vol. 4, no. 1, 1979, p. 7-11.

A novel water decomposition cycle with several reactions, some of which using a solvent, is described. Such a process makes it possible to lower the maximum temperature of the endothermic reactions, and the increase in the required amount of heat does not appreciably affect the thermal efficiency. The decomposition of water into hydrogen and oxygen is carried out by means of redox couples  $\text{Ag}^+/\text{Ag}(\text{O})$  and  $\text{Cu}^{2+}/\text{Cu}^+$ . The water-splitting cycle involves four main reaction steps. Experimental results are found to be in good agreement with thermodynamic calculations. A thermal efficiency of about 41% is obtained at a maximum temperature of 570 C. S.D.

**A79-31154 Direct thermomagnetic splitting of water.** R. L. Curl (Michigan, University, Ann Arbor, Mich.). *International Journal of Hydrogen Energy*, vol. 4, no. 1, 1979, p. 13-20. 14 refs. Research supported by the Organization Control Services, Inc.

The application of a magnetic field to water tends to cause its decomposition into hydrogen and oxygen. Based upon the thermomagnetochemistry of the phenomenon, a process is suggested for carrying out the reaction and separating the product hydrogen and oxygen. The process would have nearly Carnot efficiency, although the requisite magnetic field (about 10,000 tesla) is not at present attainable. (Author)

**A79-31156 Hydrogen storage in FeTi - Surface segregation and its catalytic effect on hydrogenation and structural studies by means of neutron diffraction.** G. Busch, L. Schlapbach, F. Stucki (Eidgenössische Technische Hochschule, Zurich, Switzerland), P. Fischer (Eidgenössische Technische Hochschule, Würenlingen, Switzerland), and A. F. Andresen (Institut für Atomenergi, Kjeller, Norway). *International Journal of Hydrogen Energy*, vol. 4, no. 1, 1979, p. 29-39. 19 refs. Research supported by the Swiss National Science Foundation.

**A79-31183 The contribution of plasma dielectric properties to the cyclotron radiation spectrum from a tokamak plasma.** C. M. Celata and D. A. Boyd (Maryland, University, College Park, Md.). *Nuclear Fusion*, vol. 19, Apr. 1979, p. 423-441. 13 refs. Research supported by the U.S. Department of Energy and NSF.

The effects of the dielectric properties of the plasma on the cyclotron radiation spectrum from a tokamak discharge are investigated for propagation perpendicular to the magnetic field. At the cutoffs and at the upper-hybrid resonance the cold-plasma dispersion relation is assumed to be valid. It is shown that the presence of evanescent regions, cutoff surfaces, and an upper-hybrid resonance surface in the plasma distorts the line shape at the lower harmonics when plasma and cyclotron frequencies are of the same order. The first-harmonic extraordinary-mode emission is suppressed as the plasma/cyclotron frequency ratio at the center of the discharge increases owing to decoupling of the electromagnetic wave from the plasma electrons. A computer study is made of the changes in the spectrum as the plasma/cyclotron frequency ratio at the center of the discharge is increased. The anisotropy of the cyclotron radiation spectrum about the minor axis of the torus is also investigated. Both line width and shape depend on the viewing direction. (Author)

**A79-31184 Radial transport in the ELMO Bumpy Torus in collisional regimes.** E. F. Jaeger and C. L. Hedrick, Jr. (Oak Ridge National Laboratory, Oak Ridge, Tenn.). *Nuclear Fusion*, vol. 19, Apr. 1979, p. 443-453. 18 refs. Contract No. W-7405-eng-26.

Neutral and charged-particle densities and temperatures are calculated as functions of radius for the toroidal plasma in the ELMO Bumpy Torus (EBT). Energy-dependent ionization and charge exchange rates, ambipolar diffusion, and self-consistent radial electric-field profiles are included. Variations in the magnetic field



due to finite toroidal plasma pressure and transport due to drift waves and magnetic-field errors are neglected. When the large electric-field limit of the neoclassical transport coefficients is used, results are limited to relatively cool electrons (electron kinetic energy about 100-200 eV) and collisional scaling for radially inward-pointing electric fields. (Author)

**A79-31185** Interpretation of cyclotron radiation spectra from runaway discharges in TFR. S. Tamor (Science Applications, Inc., La Jolla, Calif.). *Nuclear Fusion*, vol. 19, Apr. 1979, p. 455-460. 18 refs. Contract No. EY-76-C-03-1018.

The cyclotron radiation spectra from runaway tokamak discharges are discussed and numerical studies reported which attempt to fit the observed data with simple model distribution functions. A model is exhibited which is both physically reasonable and in qualitative agreement with experiment. A tentative attempt is made to compare this result with the theory for runaway dynamics of Parail and Pogutse. It is found that a consistent picture can be formulated if some assumptions are made concerning initial breakdown conditions. (Author)

**A79-31186** A ray-tracing analysis of fast-wave heating of tokamaks. B. D. McVey (Wisconsin, University, Madison, Wis.). *Nuclear Fusion*, vol. 19, Apr. 1979, p. 461-468. 20 refs. NSF Grant No. ENG-75-19259.

The complete linear hot-plasma dispersion relation, derived from kinetic theory is numerically solved for the ion cyclotron range of frequencies. A compact dispersion relation is obtained which is an accurate approximation for both fast and ion Bernstein waves. With the help of this dispersion relation, the three-dimensional ray equations for a tokamak geometry are solved, parabolic density and temperature profiles, the  $1/R$  variation in the toroidal magnetic field, and the resulting poloidal magnetic field due to a rotational transform being incorporated. The ray-tracing analysis is applied to a conceptual design tokamak reactor. The results indicate the nature of the scaling of fast-wave heating to large tokamaks. (Author)

**A79-31188** The effects of wall temperature on light impurities in Alcator. E. S. Marmor, D. Overskei, H. Helava (MIT, Cambridge, Mass.), K. I. Chen, J. L. Terry, and H. W. Moos (Johns Hopkins University, Baltimore, Md.). *Nuclear Fusion*, vol. 19, Apr. 1979, p. 485-488. 9 refs. Contracts No. ET-78-C-01-3019; No. EY-76-S-02-2711.

The effects of wall temperature on light impurity concentrations in the Alcator tokamak were measured spectroscopically. The results show that the temperature reduction decreases the influx of oxygen by a factor of 4-5 in normal tokamak operation when the wall temperature dropped from 450 to 77 K but does not affect the other light impurities (N, C). (Author)

**A79-31189** MHD stability of Spheromak. M. N. Rosenbluth (Institute for Advanced Study, Princeton, N.J.) and M. N. Bussac (Institute for Advanced Study, Princeton, N.J.; Ecole Polytechnique, Palaiseau, Essonne, France). *Nuclear Fusion*, vol. 19, Apr. 1979, p. 489-498. 13 refs. Contract No. EY-76-S-02-3237.

The 'Spheromak', an optimal force-free spherical plasma configuration, is analysed for its MHD stability properties. It is shown that flattened ellipse (oblimak) with the current-density vector equal to the magnetic-field vector times a position-independent constant should be stable against all magnetically driven MHD and resistive tearing modes if surrounded by a conducting wall at about 1.15 times the radius of the sphere. Betas of at least 2% can be stably confined, equivalent to 20% in tokamaks. (Author)

**A79-31192** MHD gas turbine energy conversion for mirror fusion reactors. S. Shioda and K. Maeda (Tokyo Institute of Technology, Tokyo, Japan). *Nuclear Fusion*, vol. 19, Apr. 1979, p. 508-514. 12 refs.

An MHD gas turbine energy conversion system for mirror fusion reactors is proposed. An inert-gas working fluid, which has been heated in the blanket, is super-heated in a plasma thermalizer up to

2800-3000 K, where the charged-particle energy from the open ends of a mirror and from neutral-beam injectors is thermalized. Overall-efficiency calculations show that the MHD gas turbine system shows great potentialities for overall-efficiency increase as well as for a reduction in the capital cost of a mirror reactor conversion system, and that the overall efficiency of the MHD gas turbine system becomes larger than that of the electrostatic Venetian-blind-direct energy convertor system with a steam-turbine bottoming cycle when the reactor blanket outlet temperature is higher than 1300 K. (Author)

**A79-31193** Large tokamak experiments - Report on the Third IAEA Technical Committee Meeting, Paris, 1-6 September 1978. B. J. Green. *Nuclear Fusion*, vol. 19, Apr. 1979, p. 515-534. 9 refs.

Progress reports on large tokamak experiments presently under construction are summarized. The status of the tokamak program is discussed, along with outstanding problems in achieving controlled fusion and technical aspects of the TFTR, JET, JT-60, and T-10 M devices. The future program in tokamak research is outlined. Specific attention is given to recent advances in plasma heating and confinement, divertor operation, thermal energy transport, long-discharge operation of tokamaks, plasma diagnostics, magnet systems for large tokamaks, power supplies, shielding, maintenance, design considerations for true fusion reactors, vacuum systems, control and data acquisition systems, superconducting-coil tokamaks, and divertor tokamaks. F.G.M.

**A79-31315** Case history - Hybrid passive/active solar system: Performance and cost. B. D. Hunn (California, University, Los Alamos, N. Mex.). (American Society of Heating, Refrigerating and Air-Conditioning Engineers, Symposium on Passive Solar Systems, Philadelphia, Pa., Jan. 28-Feb. 1, 1979.) *ASHRAE Journal*, vol. 21, Apr. 1979, p. 25-30.

The design, construction, cost, and initial operation of a hybrid passive/active solar-heated house in Los Alamos, NM, is described. In the active mode, a blower circulates air through the Trombe (thermal storage) wall air space and into a rock bed with a 3-zone forced air distribution system connected to it. A separate flat-plate collector array heats a preheater tank for domestic hot water. Energy consumption records indicate that about 60% of the net space heating load was provided by solar energy. A.A.

**A79-31316** Heat pump design - Cost effectiveness in the collection, storage and distribution of solar energy. J. G. Cottingham (Brookhaven National Laboratory, Upton, N.Y.). (American Society of Heating, Refrigerating and Air-Conditioning Engineers, Symposium on Solar-Assisted Heat Pumps, Philadelphia, Pa., Jan. 28-Feb. 1, 1979.) *ASHRAE Journal*, vol. 21, Apr. 1979, p. 35-38. 11 refs. Research sponsored by the U.S. Department of Energy.

**A79-31347** Effects of minority-carrier storage at the interface states on the fill factor of m.i.s. solar cells. O. M. Nielsen (Danmarks Tekniske Højskole, Lyngby, Denmark). *IEEE Journal on Solid-State and Electron Devices*, vol. 3, Mar. 1979, p. 51-55. 15 refs.

Current-voltage characteristics obtained under dark and illuminated conditions have been examined for Al-p-Si MIS solar cells. The results obtained show that the voltage across the cells taken at the maximum-power point is typically 50 mV smaller when the cells are illuminated compared to the voltage at the same point in darkness. This is explained as an increase in the recombination current and as an increased concentration of minority carriers at the interface states of about 10 trillion/sq cm when going from dark to illuminated conditions. The result is that the fill factor obtained from the illuminated characteristic is about 9% smaller than if the fill factor is calculated from the dark characteristics. (Author)

**A79-31351** Fiat Research Center hybrid vehicle prototype. L. Morello, R. Piccolo, and L. Ippolito (Fiat S.p.A., Turin,



Italy). *Society of Automotive Engineers, Congress and Exposition, Detroit, Mich., Feb. 26-Mar. 2, 1979, Paper 790014*. 11 p. 7 refs.

Mathematical models to evaluate the energy consumption of hybrid propulsion systems are presented, and road tests of a prototype hybrid propulsion vehicle are reported. The mathematical model incorporates several component analyses, including a thermal engine represented by a fuel consumption map, an efficiency map for a compound dc electric machine, a simulation of normal battery operation, a transmission system model, and clutch and torque converter models. A modular computerized version of the mathematical models provides a flexible instrument for analyzing a number of hybrid propulsion systems. Analysis of a prototype hybrid propulsion vehicle indicates fuel savings of about 18% with respect to conventional traction vehicles. J.M.B.

**A79-31352** Efficiency studies about Daihatsu engine/electric hybrid system. S. Honda, C. Hoshino, S. Kawakatsu, H. Tsukano, T. Yamamoto, and M. Iida (Daihatsu Motor Co., Ltd. Japan). *Society of Automotive Engineers, Congress and Exposition, Detroit, Mich., Feb. 26-Mar. 2, 1979, Paper 790013*. 18 p.

Computer simulation is adopted to study the efficiency of a 1.5-ton engine/electric hybrid truck. The truck design provides four driving modes: engine driving, engine driving with recharging, engine and electric driving, and electric driving. Fuel consumption under various driving modes is discussed. J.M.B.

**A79-31355** Air bearing development for a GM automotive gas turbine. R. J. Trippett (GM Research Laboratories, Warren, Mich.). *Society of Automotive Engineers, Congress and Exposition, Detroit, Mich., Feb. 26-Mar. 2, 1979, Paper 790107*. 11 p. 12 refs. Research supported by the General Motors Corp.

Elimination of oil from the hot section of the engine, very low running losses, and potential cost reductions are incentives to develop air bearings for the high speed rotors of automotive gas turbines. Low air bearing stiffness, start-stop wear, and high starting torque are design challenges in this application. This paper outlines analytical and experimental programs devised to evaluate air bearing usage in vehicular gas turbines. Air bearing operation has been demonstrated in engine dynamometer tests. A better understanding of the many factors which affect the performance of cantilevered-leaf air bearings has been realized through extensive rotor dynamics rig testing coupled with development of bearing analysis computer programs. Measured running losses of the air bearing are much lower than those of the oil jet lubricated ball bearing it is replacing. Increasing leaf thickness, leaf-housing attachment angle, leaf free radius and eliminating the clearance between the leaf beam and housing slot increased the bearing stiffness. (Author)

**A79-31356 \*** Foil type bearings for the Chrysler Automotive Gas Turbine Engine Program - Development and operational experiences. S. Gray (Mechanical Technology, Inc., Latham, N.Y.). *Society of Automotive Engineers, Congress and Exposition, Detroit, Mich., Feb. 26-Mar. 2, 1979, Paper 790109*. 19 p. 8 refs. Research supported by the U.S. Department of Energy and NASA.

**A79-31357** EPRI/TVA pilot electric vehicle demonstration program. R. J. Ferraro (Electric Power Research Institute, Palo Alto, Calif.) and D. L. Harbaugh (Southern California Edison Co., Los Angeles, Calif.). *Society of Automotive Engineers, Congress and Exposition, Detroit, Mich., Feb. 26-Mar. 2, 1979, Paper 790110*. 9 p.

The considered program is mainly concerned with the identification of the potential interactions between large-scale use of electric vehicles (EVs) and utility operations. By combining reliable EVs with present day state-of-the-art data collection technology the two year pilot demonstration will establish the characteristics and capabilities of EVs in a representative operating environment within the electric utility industry. The key requirements for an EV support infrastructure are to be established for viable, larger-scale demonstration programs. Other objectives are related to the identification of optimum ways for the electric utility industry to participate in

larger-scale demonstration programs, and the identification of high priority areas of research, design, and development for EVs. G.R.

**A79-31358** The London Electric Delivery Van Assessment Scheme. G. W. Wicken (Department of Industry, Vehicles Div., London, England). *Society of Automotive Engineers, Congress and Exposition, Detroit, Mich., Feb. 26-Mar. 2, 1979, Paper 790111*. 13 p. 15 refs.

The performance, reliability and maintenance and running costs of 62 battery electric delivery vans, supplied by three manufacturers, in daily use in the Greater London area are being assessed over a three year period in comparison with closely equivalent conventional vehicles on similar duties. The primary purpose is to obtain independent operational experience covering a wide variety of suitable applications over an extended period and provide reliable factual information about the performance of the vehicles in normal daily use with typical loads and drivers. Information of value to operators, the industry and Government will be produced. (Author)

**A79-31360** Some design considerations of automotive gas turbines. R. A. Mercure (U.S. Department of Energy, Div. of Transportation Energy Conservation, Washington, D.C.). *Society of Automotive Engineers, Congress and Exposition, Detroit, Mich., Feb. 26-Mar. 2, 1979, Paper 790128*. 10 p. 10 refs.

The development of the gas turbine engine as a possible alternative to the spark-ignition and compression-ignition engines has been considered in connection with objectives related to the reduction of fuel consumption and environmental considerations. Efforts directed towards the development of a gas engine for the automobile during the last 30 years have, however, failed to produce a satisfactory engine. The reported investigation is concerned with the problems that remain to be solved particularly in regard to the design and manufacturing areas. A cursory examination on the benefits of increasing cycle temperature is made. Possible solutions to these problems are then suggested as areas for concentration of future research and development efforts. G.R.

**A79-31361** Field experience with the Detroit Diesel Allison 404/505 industrial gas turbine engines. E. E. Flanagan and D. N. Nigro (General Motors Corp., Detroit Diesel Allison Div., Detroit, Mich.). *Society of Automotive Engineers, Congress and Exposition, Detroit, Mich., Feb. 26-Mar. 2, 1979, Paper 790129*. 27 p.

Detroit Diesel Allison Division of General Motors Corporation conducted a field evaluation program on the 300 hp GT-404-3 and the 390 hp GT-505-3 industrial gas turbine engines. The overall program plan, involving installations in trucks, coaches, marine and industrial applications, as well as the field experience accumulated to date, are discussed. Two particular applications are explored in detail: the bulk hauling trucks with self unloading capabilities, and the Greyhound inter-city coach operation with gas turbine power and automatic transmissions. The gas turbine engines were shown to have performed well in all the encountered applications, especially in the bulk unloading and Greyhound cases. Performance of heavy trucks and coaches on ice was found to be superior to anything on the road both during engine braking and starting on hills. A.A.

**A79-31363** Electric vehicle battery development. C. W. Fleischmann (Eltra Corp., Electric Vehicle Group, Plymouth Meeting, Pa.). *Society of Automotive Engineers, Congress and Exposition, Detroit, Mich., Feb. 26-Mar. 2, 1979, Paper 790158*. 11 p. 32 refs. ERDA Contracts No. 31-109-38-3628; No. 31-109-38-4206.

A description is presented of the development of a new lead-acid battery for electric vehicle propulsion applications. The battery which is being developed uses expanded metal, nonantimonial alloy grids, enveloped separation/retention, and high-rate production methods of packaging including through-the-wall construction. The battery is expected to meet the Department of Energy goals for the improved state-of-the-art electric vehicle battery and to be further improved to meet the Department of Energy goals for the advanced battery. G.R.

**A79-31366** Thermal management of the lithium/metal sulfide electric vehicle. M. M. Farahat, J. A. E. Graae, A. A. Chilenskas, and D. L. Barney (Argonne National Laboratory, Argonne, Ill.). *Society of Automotive Engineers, Congress and Exposition, Detroit, Mich., Feb. 26-Mar. 2, 1979, Paper 790161*. 7 p.

Thermal management studies of the lithium-aluminum/metal sulfide battery have indicated the need for a light-weight high thermal efficiency case for electric batteries. Calculations based upon the rectangular configured MK IA battery using vacuum-foil insulation, show that the heat loss rate goal of 400 W can be met. Experimental studies directed at the determination of the reversible heating gave results that compared within 8% with theoretically derived values. Calculations based upon the 50-kWh MK II battery and a 10,000 miles driven/year show that by utilizing the thermal storage capacity of the system, essentially no additional energy is needed to keep the battery hot. (Author)

**A79-31367** A high energy tubular battery for a 1800 kg payload electric delivery van. M. L. Whitehead (Chloride Technical, Ltd., England). *Society of Automotive Engineers, Congress and Exposition, Detroit, Mich., Feb. 26-Mar. 2, 1979, Paper 790162*. 10 p.

A high energy lead-acid battery was developed to provide, at no extra cost, a 1800 kg (4000 lb) payload electric delivery van with a driving range of 80 - 90 km (50 to 55 miles). In addition to the new high performance electrodes, an integrated approach to the total power source concept evolved new lightweight designs for battery packaging, a system-engineered battery charger, and an automatic topping-up facility. Despite the 40% improvement in range, as compared to 55 - 65 km (35 - 40 miles) for conventional traction batteries, a 4 year battery life is expected due to the reinforcing features of the tubular design adopted for the positive electrode. (Author)

**A79-31368 \*** Initial comparison of single cylinder Stirling engine computer model predictions with test results. R. C. Tew, Jr., L. G. Thieme, and D. Miao (NASA, Lewis Research Center, Cleveland, Ohio). *Society of Automotive Engineers, Congress and Exposition, Detroit, Mich., Feb. 26-Mar. 2, 1979, Paper 790327*. 18 p. 15 refs.

A NASA developed digital computer code for a Stirling engine, modelling the performance of a single cylinder rhombic drive ground performance unit (GPU), is presented and its predictions are compared to test results. The GPU engine incorporates eight regenerator/cooler units and the engine working space is modelled by thirteen control volumes. The model calculates indicated power and efficiency for a given engine speed, mean pressure, heater and expansion space metal temperatures and cooler water inlet temperature and flow rate. Comparison of predicted and observed powers implies that the reference pressure drop calculations underestimate actual pressure drop, possibly due to oil contamination in the regenerator/cooler units, methane contamination in the working gas or the underestimation of mechanical loss. For a working gas of hydrogen, the predicted values of brake power are from 0 to 6% higher than experimental values, and brake efficiency is 6 to 16% higher, while for helium the predicted brake power and efficiency are 2 to 15% higher than the experimental. A.L.W.

**A79-31369** An air/fuel control system for the Stirling engine. J. E. Fenton (Ford Motor Co., Detroit, Mich.). *Society of Automotive Engineers, Congress and Exposition, Detroit, Mich., Feb. 26-Mar. 2, 1979, Paper 790328*. 7 p. Contract No. EC-77-C-02-4396.

An air/fuel control system has been developed for the Stirling engine, which derives power from its continuous external combustion process. The repeatable air/fuel control system provides a wide range of metered fuel flows and adjustable air/fuel ratios, necessary features for the mapping and optimization of Stirling engine components. The control system includes control of the fuel flow and combustion air flow, measurement of the combustion air flow and the hydrogen temperature at the heater head, and control of the exhaust gas recirculation. J.M.B.

**A79-31370** The Stirling engine for automotive application. K. Rosenqvist, T. Lia (United Stirling of Sweden, Malmö, Sweden), and B. Goldwater (Mechanical Technology, Inc., Latham, N.Y.). *Society of Automotive Engineers, Congress and Exposition, Detroit, Mich., Feb. 26-Mar. 2, 1979, Paper 790329*. 15 p. 7 refs.

A program for the development of a Stirling engine for automotive passenger car applications was initiated by a Swedish and a U.S. company. The engine is to be based on a 4-cylinder, double acting, crank driven design that is being developed in Sweden since 1968. Derivatives of this engine design have been considered for many other applications, including stationary power generator systems, truck propulsion, underground mining power systems, heat pumps, and solar engines. A description is provided of the general state of Stirling engine technology that exists at the two companies. After initial development work, the Stirling engines are now being considered as an alternative power plant for automotive application. Although it has been claimed by industry that the Stirling engine is bulky and heavy, the recent concept of design has decreased weight and manufacturing cost significantly which makes it commercially attractive for medium duty application. G.R.

**A79-31371** A one-dimensional combustion model for a dual chamber stratified charge spark ignition engine. S. C. Sorenson and S. S. Pan (Illinois, University, Urbana, Ill.). *Society of Automotive Engineers, Congress and Exposition, Detroit, Mich., Feb. 26-Mar. 2, 1979, Paper 790355*. 19 p. 33 refs.

A model has been developed for simulating the combustion in a three-valve stratified charge spark ignition engine. The conservation equations for mass, momentum, chemical species, and energy are numerically integrated for a one-dimensional flame using an empirical model for turbulent diffusivity. The chemical reaction of the fuel and air is modeled using simple kinetics in a one-step reaction and experimentally determined ignition delays are used. Nitric oxide emissions are calculated using a simple Zeldovich model with steady state atomic nitrogen and equilibrium atomic oxygen. Effects of various assumptions and parameters in the model are discussed and comparisons with experimental data from a single-cylinder engine are presented. (Author)

**A79-31374** Emissions and economy potential of prechamber stratified charge engines. D. L. Dimick, S. L. Genslak, R. E. Greib, and M. J. Malik (General Motors Corp., Detroit, Mich.). *Society of Automotive Engineers, Congress and Exposition, Detroit, Mich., Feb. 26-Mar. 2, 1979, Paper 790436*. 17 p. 6 refs.

Research investigation on the potential of prechamber stratified charge engines as alternatives to conventional engines is reviewed. A single-cylinder engine study is taken into account, as is design and development of two multicylinder engines incorporating prechamber 3-valve configurations. A car development and evaluation program using both small and large cars with alternative engine configurations and aftertreatment devices, is outlined. It is concluded that the prechamber stratified charge engines possess NOx emission and fuel economy performance similar to a conventional engine but at a high HC emission level. A.A.

**A79-31375** The influence of overall equivalence ratio and degree of stratification on the fuel consumption and emissions of a prechamber, stratified-charge engine. J. F. Sinnamon (GM Research Laboratories, Warren, Mich.) and D. E. Cole (Michigan, University, Ann Arbor, Mich.). *Society of Automotive Engineers, Congress and Exposition, Detroit, Mich., Feb. 26-Mar. 2, 1979, Paper 790438*. 19 p. 25 refs. NSF-supported research.

An experimental study of a divided-chamber, stratified-charge engine was made using a modified CFR L-head engine. Emissions and fuel consumption were measured over a wide range of overall fuel-air ratio and degree of stratification by varying the prechamber and main chamber inlet fuel-air ratios. Trends in the emissions data were evaluated by analyzing the combustion process and the spatial distribution of fuel-air ratio in the combustion chamber or measured by a sampling valve. It was found that NOx emissions increase with increasing degree of stratification at lean overall fuel-air ratios. A.A.

**A79-31376** A new combustion system in the three-valve stratified charge engine. S. Yagi, I. Fujii, M. Nishikawa, and H. Shirai (Honda Research and Development Co., Ltd., Tokyo, Japan). *Society of Automotive Engineers, Congress and Exposition, Detroit, Mich., Feb. 26-Mar. 2, 1979, Paper 790439*. 10 p.

The branched conduit combustion system has been developed to reduce exhaust emissions from the three valve stratified charge automobile engine. The system consists of a main combustion chamber, similar to that of the original stratified charge engine, connected to an auxiliary combustion chamber by a long tapered torch passage, from which other passages (branched conduits) branch out and open into the main combustion chamber. Tests show that hydrocarbon and NO<sub>x</sub> emissions in the branched conduit engine are 20% lower than in the conventional stratified charge engine, and exhaust gas temperature is 30 C higher. High speed photographs of combustion processes show that combustion terminates later in the branched conduit engine and is more stable, indicating that the branched conduits allow unburnt gases to recirculate. A taper angle of the torch passage of 10 degrees and the existence of three branched conduits are shown to minimize hydrocarbon emissions, and the location of the branch point is also shown to have an effect.

A.L.W.

**A79-31401** Renewable alternatives; Proceedings of the Fourth Annual Conference, University of Western Ontario, London, Canada, August 20-24, 1978. Volumes 1 & 2. Conference sponsored by the Solar Energy Society of Canada, Ministry of Energy, Mines and Resources, National Research Council of Canada, et al. Winnipeg, Solar Energy Society of Canada, Inc., 1978. Vol. 1, 731 p.; vol. 2, 277 p. In English and French. Price of two volumes, \$29.47.

Flat plate collectors are discussed, taking into account new approaches regarding the ranking and evaluation of flat plate collectors, the optimization of the flow passage geometry for air heating solar collectors, the performance analysis of a flat plate solar collector using 'forge-fin' tubes, an energy analysis of an aluminum solar collector, the dimensional relations for free convective heat transfer in flat plate collectors, optimization studies on black chrome electroplating variables for solar selective surfaces, and the application of the honeycomb heat trap in flat plate solar collectors. Attention is also given to concentrators, aspects of heat storage, photochemistry and photovoltaics, testing, radiation measurement, the utilization of the ocean temperature difference, monitoring and performance reports, biomass energy, wind energy, economics, energy policy, solar heating, solar domestic hot water, simulation, controls, the heat pump, solar cooling, life styles, conservation, and passive heating.

G.R.

**A79-31402** Ranking and evaluation of flat-plate collectors - Two new approaches. J. H. White (Dilworth, Secord, Meagher and Associates, Ltd., Toronto, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 1. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 12 p.

An index format is developed which will allow ready ranking of a collector's ability to deliver heat to a seasonal-storage system. It is location sensitive but not configuration sensitive. There are indications that the index could also be applicable to short storage systems and be developed further into a system design tool. When used in conjunction with a reference system which presents the optimum efficiency in terms of a number of 'equivalent reflections' and an 'equivalent resistance' concept, it is possible to see that single-glazed collectors, to date, are quite restricted in their ability to deliver heat, while some antireflective double-glazed collectors with selective coatings have established double the index margins and therefore almost double the heat delivering capability when used in seasonal-storage systems.

G.R.

**A79-31403** Optimization of the flow passage geometry for air heating solar collectors. E. C. Shewen and K. G. T. Hollands (Waterloo, University, Waterloo, Ontario, Canada). In: Renewable

alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 1.

Winnipeg, Solar Energy Society of Canada, Inc., 1978. 12 p. 9 refs. Department of Supply and Services Contract No. 12SQ-31155-7-4409.

The flow passage geometry for air heating solar collectors of the underflow type has been examined from the point of view of maximizing the collector efficiency for a specific pressure drop. Parameters studied include the absorber to air stream heat transfer coefficient, the flow passage dimensions, the pressure drop and the air flow rate. A generalized study of improving the heat transfer coefficient for a specified pressure drop is presented. This study has led to a novel air heater design referred to as the 'short path concept'.

(Author)

**A79-31404** Performance analysis of a flat-plate solar collector using 'forge-fin' tubes. K. F. Schenk, C. R. Dua, and J. T. Munoz (Ottawa, University, Ottawa, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 1. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 14 p. 9 refs. Research supported by the National Research Council of Canada.

An analysis is conducted of a flat-plate solar collector utilizing internally finned tubes to obtain its thermal performance. These 'forge-fin' tubes enhance the heat transfer between fluid and absorbing plate. A solar test facility was built and the collector efficiency obtained. It was found that the efficiency of the proposed collector using internally finned tubes is about 10% higher than that of a conventional type of flat-plate collector under similar outdoor conditions. It had been pointed out by Watkinson et al. (1974) that 2 feet of 'forge-fin' tube was equivalent to 8 feet of smooth tube in heat exchangers due to its augmented heat transfer properties. After evaluation of the performance of the proposed flat-plate solar collector using these tubes, an improvement has been noticed over that of a collector using smooth tubes. However, 'forge-fin' tubes are more expensive than conventional smooth tubes and this increases the cost per unit area of the proposed collector.

G.R.

**A79-31405** Energy analysis of an aluminum solar collector. W. Ashton and J. E. Robinson (Waterloo, University, Waterloo, Ontario, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 1. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 9 p. 20 refs.

An analysis was conducted of the energy consumption involved in an installation of aluminum solar collectors to ascertain the length of time which would be required to recover the energy invested in manufacture. It was found that approximately four years of operation will be required to regain the energy consumed in the manufacture of the solar collector system from raw materials. It was also found that the use of recycled metal substantially reduces the energy pay-back period to just over one year. In this case, then, the energy viability of one new technology, a solar collector system, is enhanced significantly by parallel developments in others such as metal recycling.

G.R.

**A79-31406** Dimensional relations for free convective heat transfer in flat-plate collectors. K. G. T. Hollands (Waterloo, University, Waterloo, Ontario, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 1. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 12 p. 11 refs. Research supported by the U.S. Department of Energy.

Free convection heat transfer is one of the dominant modes of heat loss in a flat plate solar collector. Recently there have been reported new data and correlation equations for free convective heat transfer in various geometries similar to those found in solar collectors. In most of this work, the results have been reported in terms of dimensionless groups. This method of presentation does not immediately indicate how the results may be used for design decisions on collectors. A description is presented of the new results in terms of dimensional equations and graphs, thereby pointing the

way to improved design techniques. Particular emphasis is placed on the new free convective information resulting from studies carried out at the University of Waterloo. G.R.

**A79-31407 Optimization studies on black chrome electroplating variables for solar selective surfaces.** A. R. Balakrishnan, K. G. T. Hollands, E. C. Shewen, and P. Niessen (Waterloo, University, Waterloo, Ontario, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 1. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 11 p.

A description is given of the results of a study whose object was to identify and optimize the variables involved in obtaining a black chrome coating that has as high a short wave absorptivity and as low a long wave emissivity as possible. In addition humidity testing was performed to get a qualitative measure of the durability of these surfaces. Substantial differences were observed between the characteristics of the black chrome versions of two U.S. manufacturers. It was found that the bath temperature influences the behavior of the electroplating process. Black chrome on nickel plate steel exhibits excellent resistance to humidity degradation. G.R.

**A79-31408 Thermal performance evaluation of a flat-plate cylindrical parabolic concentrator and a flat-plate collector.** P. Singh and K. F. Schenk (Ottawa, University, Ottawa, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 1. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 13 p. 6 refs. Research supported by the National Research Council of Canada.

An investigation is conducted regarding the design, building, and testing of a flat-absorber cylindrical parabolic concentrator (CPC) and a conventional type of flat-plate collector. Experimental studies showed that the flat-absorber CPC is more cost-effective than the conventional flat-plate collector, if operated at solar noon under the specified conditions. Although the flat-absorber CPC utilizes much less absorber plate area, the total cost per unit area for both the collectors balances out because of the additional cost of the reflecting surface. However, it is expected that the cost of labor in building the parabolic surface would be reduced marginally by mass production. Another important consideration is that since the absorber width is large enough to receive even the off-axis incident rays, no tracking mechanism is needed. The collector can also be operated on cloudy or hazy days. G.R.

**A79-31409 Studies on the effect of bed aspect ratios and pressure drop on flow distribution in rock bed storage systems for solar energy applications.** A. R. Balakrishnan, H. F. Sullivan, and K. G. T. Hollands (Waterloo, University, Waterloo, Ontario, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 1. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 11 p. 5 refs. Department of Supply and Services Contract No. 12SO-31155-7-4410.

A description is given of an experimental investigation of the flow distribution characteristics across any plane normal to the direction of flow and of the factors which affect these characteristics. The importance of ensuring even or uniform flow distribution to avoid any adverse effect on the thermal performance of the rock bed is pointed out. An indication of the flow distribution, i.e., the relative fluid velocity along a cross-section of the bed, was obtained using thermocouples measuring the air temperature. By monitoring the time taken for the temperature wave in the air stream to pass through a given depth of the bed at a given position in the bed cross-section and comparing this with a similar measurement at another location, a measure of the corresponding air velocities relative to one another is obtained. G.R.

**A79-31410 Distributed energy storage for solar applications.** L. Holt and R. Scheithauer (U.S. Department of Energy, Div. of Energy Storage Systems, Washington, D.C.). In: Renewable

alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 1.

Winnipeg, Solar Energy Society of Canada, Inc., 1978. 9 p. 9 refs.

Energy storage systems have the potential to reduce electric utility peak load burdens and residential customer energy bills by storing electricity during off-peak periods, when generating costs are low, and making the electricity available during peak load periods. Two basic categories of storage systems are related to centralized energy storage at utility power stations and either customer or utility owned decentralized energy storage sited at the location of end use. The reported investigation focuses on distributed (i.e., decentralized) thermal storage for residential applications. Conventional hydro pumped storage is currently the only proven technology and is now in wide use. For the intermediate-term (1985-2000) advanced batteries appear to be attractive. Hydrogen storage system may also prove to be economic. G.R.

**A79-31411 Measuring the quasi-Fermi level and flat band potential of an illuminated Au/n-GaAs(6P/4) anode.** W. E. Pinson (Infrared Photo, Ltd., Ottawa, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 1. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 12 p. 11 refs.

**A79-31412 Photovoltaic properties of metal-free phthalocyanines - A1/H2Pc Schottky barrier solar cells.** R. O. Loutfy and J. H. Sharp (Xerox Research Centre of Canada, Ltd., Mississauga, Ontario, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 1. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 10 p. 10 refs.

At present the material and fabrication costs of inorganic solar cells are far above projected goals. On the other hand, organic photovoltaic devices potentially offer low material and device manufacturing costs. A new approach is presented to the fabrication of low cost organic solar cells, namely, the use of particulate semiconductors. The considered device consists of a solvent coated dispersion of photoactive particles in a polymer binder on a conductive substrate, and then a semitransparent barrier electrode evaporated on top of the organic film to form a Schottky barrier solar cell. To demonstrate the feasibility of the considered approach, polycrystalline x-metal-free phthalocyanine (x-H2Pc) was used for initial experiments. The reported work includes detailed photovoltaic studies on NESA/x-H2Pc cells. G.R.

**A79-31413 A solar collector thermal performance test for developmental programs.** E. C. Shewen and K. G. T. Hollands (Waterloo, University, Waterloo, Ontario, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 1. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 13 p. 8 refs. Department of Supply and Services Contract No. 12SO-31155-7-4409.

An alternative thermal test procedure for solar collectors to that described in ASHRAE Standard 93-77 is described. Particularly suited to in-house developmental programs, the method permits a substantial reduction in the time required for test completion, while yielding an accuracy that should be comparable, for a given type of design. Considerable use is made of indoor heat loss testing and only one outdoor test is required. In this paper the method is outlined and a procedure for correcting the results to standard ambient conditions is described. A description of a test apparatus for air-heating collectors, built at the University of Waterloo is given and some experience in design of mixers and thermocouple collars is reported. (Author)

**A79-31414 The role of applied meteorology in the Canadian energy programme.** D. C. McKay (Department of the Environment, Atmospheric Environment Service, Downsview,

Ontario, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 1. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 13 p. 12 refs.

Conventional energy sources cannot withstand the present level of demand for long. Until improved sources are available in the desired quantities and locations, conservation of present energy stores is imperative. Conservation is an appealing alternative; from the viewpoint of return on investment, feasibility, and overall social benefits it vies favorably with other major energy development thrusts. To promote this energy alternative, applied meteorology can play a dominant role. To aid in the development of renewable resources and energy efficiency in residences and buildings in Canada, an Energy program has been initiated. The projects to be developed are initially in the realm of solar energy, wind energy, and energy efficiency. G.R.

**A79-31415** An ocean thermal difference power plant in the Canadian Arctic. R. K. Swartman (Western Ontario, University, London, Canada) and R. Green. In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 1. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 12 p. 17 refs.

A variation on the scheme of using the temperature differences of the ocean waters is to use the Arctic atmosphere as the heat sink and ocean waters as the source. The proposed system uses a closed Rankine cycle operating between the temperatures of the Arctic Ocean and the colder Arctic atmosphere. The working fluid is evaporated in a vapor generator by the transfer of heat from seawater and is condensed after passing through a turbine, rejecting heat to the atmosphere. Two essential components of this proposal are a seawater-working fluid heat exchanger for the vapor generator and an air-working fluid heat exchanger for the condenser. G.R.

**A79-31416** Solar power plants. E. Bilgen and J. P. Bourquin (Lemieux, Monti, Nadon, Roy, Inc., Montreal, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 1. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 16 p. 9 refs.

It is estimated that Canadian oil and natural gas resources will be virtually exhausted before the year 2000. It is expected that the energy from nuclear fission will meet, in part, the additional demand during the next fifty years. On the other hand, the first commercial fusion reactors will probably not be available before the mid-21st century. Therefore, an alternative solution to meet short and long term energy needs is essential. The solution may be the better utilization of solar energy, an unlimited energy source. Attention is given to the prospects of solar energy in Canada, aspects of solar energy conversion, thermoelectric solar energy, the optical system, the central receiver power system, solar energy and utility companies, and existing and projected solar power plants. G.R.

**A79-31417** The Saskatchewan Conservation House - Some preliminary performance results. R. W. Besant, R. S. Dumont, and G. Schoenau (Saskatchewan, University, Saskatoon, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 1. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 17 p. 5 refs. Research supported by the Saskatchewan Housing Corp., Department of Mineral Resources, and Saskatchewan Research Council.

The performance of the Saskatchewan Conservation House for the spring of 1978 is reported. This house was designed primarily as a demonstration to the public of the energy savings possible in residential construction. The Saskatchewan Conservation House is one of a small number of residences constructed which are designed for 100% space heating using active solar collection systems. The provided report includes a listing of the theoretical and measured heat loss characteristics of the house, the passive solar gain behavior of the house, and efficiencies for the solar collector panels. Estimates

are made of the annual energy consumption of the house based on a normal occupancy pattern. G.R.

**A79-31418** Report on a survey of operational solar systems. D. Lorrimer (Raymond Moriyama, Architects and Planners, Toronto, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 1. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 8 p.

During the winter and spring of 1978, a study was undertaken for the National Research Council to survey operational solar systems in North America - especially those operating in climates similar to Canada's. The purpose of the survey was to learn from the experiences gained from these systems and to report on any problems that may have developed in order to identify areas that require further research. Although the collector component of the systems received the most attention, other parts of the systems were also considered. The survey included a literature review, a mailed questionnaire programme and site visits to over 60 installations. This paper will summarize the findings of the survey. (Author)

**A79-31419** NRC solar monitoring program. S. A. Barakat, W. E. Carscallen, and B. E. Sibbitt (National Research Council, Div. of Building Research, Ottawa, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 1. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 14 p.

As part of the federal solar heating program, the Division of Building Research of the National Research Council is responsible for an on-going monitoring program of various solar installations. The aims of the program are to determine the solar contribution to the heating needs of buildings, to provide technical data for validating solar system simulation design methods and to permit analysis of subsystem performance. The paper describes the different levels of monitoring used by NRC and lists the buildings in which these monitoring systems are or will be installed. In particular, a description is given of the monitoring equipment installed in twelve federally-funded solar heated homes, as well as their installation and calibration. Some of the problems associated with the monitoring systems are also discussed. (Author)

**A79-31420** Performance of the Meadowvale solar home. B. E. Sibbitt, H. Jung, and D. Lorrimer (National Research Council, Div. of Building Research, Ottawa, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 1. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 10 p. 6 refs.

Monitoring of the Meadowvale Solar Experiment in Mississauga, Ontario, began in October 1976 and has continued to date. The paper presents a performance summary of monitoring results of the first two complete heating seasons of solar system operation. Data for the period from October 1976 through April 1978 show that the solar system provided 51% of the space heating requirement, 14% of the service-water heating requirement and that 54% of collected energy was lost from storage. The paper also contains brief descriptions of the solar system, the house and the monitoring system. (Author)

**A79-31421** Off-peak electrical backup experience in the Meadowvale Solar Experiment. J. M. Bell (Ontario Hydro, Toronto, Canada) and D. Lorrimer. In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 1. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 11 p.

When electricity is used for backup heating in solar heated houses, the maximum electric demand usually occurs when winter-peaking utilities are least capable of supplying it. An off-peak electric backup system was designed and incorporated into the existing storage system of the Meadowvale Solar Experiment to investigate the benefits and problems associated with this mode of operation. The paper describes the design and operation of the off-peak backup

system and contains suggestions for improvements. A comparison is made of the electrical demand and consumption for 1976-77 (on-demand electrical backup) to 1977-78 (off-peak electrical backup). The electrical load curve of the house is described and compared with the Ontario Hydro system load curve with a brief discussion of the potentials and the drawbacks of the use of off-peak power. Reference is made to other work programs in this area. (Author)

**A79-31422** Measured and predicted performance of solar domestic water heaters. J. M. Bell and J. T. Strack (Ontario Hydro, Research Div., Toronto, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 1. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 15 p. 7 refs.

Solar water heating offers good potential for the conservation of electricity in Ontario, since about half of existing water heaters in this province are electric. To examine the present state-of-the-art of commercially available solar water heater systems, Ontario Hydro has purchased and tested several systems. The paper describes the systems purchased, the test program and the results. The instrumentation package including special instrumentation developed for the tests is discussed. An outline is given of a simple analytical technique which was adapted to permit accurate prediction of the annual performance of any solar water heater system on a month by month basis. (Author)

**A79-31423** The performance of a site built, air heating, vertical collector with snow reflector in Quebec. R. G. Kerr and M. M. Shapiro (Concordia University, Montreal, Canada.). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 1. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 12 p. 10 refs.

A screen-type vertical air heating collector with double glazing was installed in 1975 as the south wall of a house near La Macaza, Quebec, 170 km north of Montreal. The collector was built on site, using normal construction materials, for a gross cost of \$70/sq m, and a net cost of \$45/sq m, in 1975 dollars. The house and solar heater were monitored during the 1976-77 heating season. The noon efficiency curve of the collector compares favourably both with that of an experimental and with that of a factory-built collector. The monthly average efficiencies ranged from 32% in March to 42% in October. The ratio of solar heat to the sum of solar and baseboard heat supplied ranged from 0.29 in November to 0.76 in March, and was 0.5 over the entire heating season. Daily and monthly solar radiation and solar heat collected, plus monthly average efficiencies and solar fraction are presented. (Author)

**A79-31424** New approaches for the appropriate use of solar energy in northern climates. T. A. Lawand, H. P. Budgen, C. Ives, J. LeNormand, A. Skelton, and L. Ghanime (McGill University, Sainte Anne de Bellevue, Quebec, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 1. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 18 p. 6 refs.

A number of novel approaches in the field of solar heating are proposed for an investigation regarding a utilization in cold climate areas, taking into account attached solar rooms or greenhouses, modified Trombe walls, total roof canopies, solar heat pipes, and the long term potential of storing ambient heat and cold for the climatization of buildings. It is felt that these systems individually or in combination with standard passive heat gain techniques, will make significant contributions to the solar heating field in the future. G.R.

**A79-31425** Wind power from a vortex chamber. P. N. Wang (Toronto, University, Toronto, Canada) and I. Huang (National Tsing Hua University, Hsinchu, Nationalist China). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 1. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 9 p. 12 refs.

National Science Council of Nationalist China Contract No. 65E-0401-03(03).

In the utilization of wind energy, one of the major difficulties is the problem of low wind energy density. A new wind energy system employing the concept of confined vortex flow was proposed by Yen (1975, 1976, 1977) to overcome this difficulty. The new system, which is called tornado-type wind energy system, makes use of pressure energy. This energy is developed by utilizing the pressure difference between the ambient flow and the core of the confined vortex flow. The reported study has the objective to further investigate the feasibility of the considered approach. The pressure energy of the confined vortex flow is studied on the basis of a model test in the wind tunnel. G.R.

**A79-31426** NRC's wind energy program. R. S. Rangi, P. South, and R. J. Templin (National Research Council, Ottawa, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 1. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 15 p.

This paper describes current work on wind power assessment and on the Vertical Axis Wind Turbines at the National Research Council (NRC) Ottawa. A map showing the annual average wind power density is presented. The electrical wind power potential for all of Canada and individual provinces has been calculated from the wind power density. The wind power potential is also assessed for: (a) all land area, (b) existing electrical network +300 km, (c) existing electrical network +150 km. The theoretical and development work on the VAWT and also the demonstration projects that are sponsored by National Research Council are described. In particular, the preliminary performance data from the 200 kW Magdalen Island unit is included. (Author)

**A79-31427** The Prince Edward Island Wind Energy Program. M. Lodge (Institute of Man and Resources, Charlottetown, Prince Edward Island, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 1. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 13 p. 5 refs.

A description is presented of investigations related to the development of wind as a renewable and sustainable energy source in the Province of Prince Edward Island. The considered research and development program, which commenced in July 1977, is composed of four elements related to wind data, the integration of large Wind Energy Converter Systems (WECS), rural and farm applications of small WECS, and investigations conducted at an Atlantic wind test site. The analysis of the data obtained so far suggests that winds at exposed coastal locations in the Province of Prince Edward Island are sufficiently high to warrant the continued development and testing of a prediction model. G.R.

**A79-31428** Allowable costs for alternative domestic heating systems using utility supplied electricity for backup or charging energy. A. G. Barnstaple and P. L. Drewes (Ontario Hydro, Energy and Environmental Studies Dept., Toronto, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 1. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 15 p. 5 refs.

An outline is provided of the results of an Ontario Hydro Study which determines the economic potential for the development of various alternative heating systems from their projected electric demand characteristics. The economic potential for each system is derived through comparison of total utility plus homeowner costs with conventional electric heating. G.R.

**A79-31429** Component cost of solar energy systems. J. F. Orgill and R. M. R. Higgin. In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 1. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 17 p. 8 refs.

The solar demonstration program of the Ontario Ministry of Energy is considered and the capital cost of demonstration projects is discussed, taking into account large solar energy systems, small solar energy systems, and a comparison with other demonstration programs. Future costs of solar energy systems are examined. It is pointed out that, as with the introduction of any new technology, the cost for the first systems is high. It has been found in the past, however, that a reduced cost per unit is achieved as the accumulated production volume increased. Attention is also given to the problems experienced in tendering solar collectors and solar systems in the demonstration program. G.R.

**A79-31430** A cost effective vertical air/water solar heating collector. T. H. Markowitz and R. L. Hummel (Toronto, University, Toronto, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978, Volume 1. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 12 p. 13 refs.

A description is presented of a vertical air/water collector which combines high efficiency with low cost. The low-cost characteristics of the total system are obtained by utilizing an air system for heat collection along with a water system for heat storage. The heat exchanger is in the top of the collector. It is protected from freezing, and is available to transfer heat from the collector to storage, or from storage to the building. The collector can be constructed from inexpensive materials. The incident direct solar radiation is almost doubled by employing a reflector, made of inexpensive aluminized Mylar plastic film. G.R.

**A79-31431** Energy management through energy conservation in buildings. R. W. Besant, G. J. Schoenau, and R. S. Dumont (Saskatchewan, University, Saskatoon, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978, Volume 1. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 16 p. 31 refs.

It is pointed out that energy use in buildings is a major part of the total energy demand budget. Furthermore, buildings are a long term capital investment, much longer than the period for which energy supplies are assured at the low prices of today. Details regarding the energy dissipation in buildings operations at the present time are considered, taking into account the effects of a modification of present buildings related to a reduction in the consumption of energy. Questions regarding the reduction in energy consumption achievable in a new building designed to be energy conserving are also explored. It will be necessary to introduce a new energy code which will ensure that all future buildings will satisfy certain minimum long term energy conservation standards. G.R.

**A79-31432** Collector and storage efficiencies in solar heating systems. K. G. T. Hollands, J. W. Chinneck, and M. Chandrasekar (Waterloo, University, Waterloo, Ontario, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978, Volume 1. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 13 p. 10 refs. Department of Supply and Services Contract No. OSU77-00099.

A general definition of the efficiency of a solar collector operating in a solar energy system is presented which gives a fair method of comparison of different collectors operating in that particular application. Based on comparison between the areas required for the actual collector and that of a perfect collector - both giving the same fraction solar - the definition permits the definition of the average value of the collector input parameter. The concept of the perfect collector also leads to a fair definition for the efficiency of the storage component in a solar heating system. These parameters are evaluated for the special case of residential space heating and service hot water systems of the standardized f-chart type operating in a number of Canadian cities. Simple methods for collector comparisons result from the study and indications are that a simple solar system design method will follow. (Author)

**A79-31433** Design study on solar energy systems for commercial buildings. J. B. Bisset and P. F. Monaghan (Chorley and Bisset, Ltd., London, Ontario, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978, Volume 1. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 12 p. 13 refs. Research supported by Public Works Canada, National Research Council, and Department of Energy, Mines and Resources of Canada.

A description is presented of a preliminary study on design problems of applying solar energy to commercial buildings. The emphasis of the study is on practical aspects of design rather than on energy analysis. The problems of incorporating solar heating systems into the heating and cooling systems are considered along with the architectural and structural problems associated with mounting solar collectors on the building. The objectives of the study were to develop detailed conceptual designs for three solar system options and to estimate the relative costs of these systems, compared to two conventional heating and cooling systems. G.R.

**A79-31434** Solar energy retrofit system for an older-type building - The Williamstown Museum project. G. McKiel and E. Broomhall (John Abbott College, Sainte Anne de Bellevue, Quebec, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978, Volume 1. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 13 p. 20 refs. National Research Council Contract No. 077-9.

The rationale for the retrofit of Williamstown Museum with a solar heating system was to provide the community with a high profile, easily accessible prototype which would engender interest and provide a design basis for solar systems in extant buildings. The space heat load base was designed on a 50 F indoor temperature and -20 F outdoor temperature to give a design temperature difference of 70 F. A flat plate, back pass modular solar collector was designed, measuring 3 x 16 ft. Though 16 collector modules were needed to provide 60% of the building's thermal demand another 5 modules were added to help offset losses in the long duct runs and the change from corrugated to flat absorber plate. The collectors were hoisted to the roof by a crane. G.R.

**A79-31435** Solar heating and ventilation using the modified Trombe wall system (Chauffage et ventilation solaire par le système mur Trombe modifié). E. Bilgen and M. Chaaban (Ecole Polytechnique, Montreal, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978, Volume 1. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 7 p. In French.

A description is presented of the first stages of a theoretical and experimental investigation of the modified Trombe wall. The wall in its original form had first been considered by Trombe (1974). The Trombe wall as a solar energy collector has great thermal inertia. It performs a number of functions related to the collection of solar energy, the passing on of a part of the energy by means of a thermal circulation process, and the accumulation of the remainder of the energy in its own mass. A major problem of this system is the great loss of energy which takes place during the night. The investigation is concerned with the possibility to eliminate this drawback with the aid of an approach involving a separation of the energy collection and energy storage functions. G.R.

**A79-31436** South wall solar collector with active collector system. K. J. Linton. In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978, Volume 1. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 8 p.

The south wall of the building is constructed to act as a Solar air collector. The collector system operates in conjunction with an air to water heat pump and water storage to collect the excess solar heat received. The heat pump extracts heat from the water storage to heat the house when this is required. (Author)



**A79-31437 Domestic water preheating using solar energy.** V. M. Ireton (New Brunswick, University, Fredericton, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 1. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 11 p.

This paper reports upon the experience gained from the operation and monitoring of a closed loop solar energy collection system to preheat domestic water. The system has operated continuously and reliably since it was commissioned in late March 1977. Data collection began on April 1, 1977 and has continued to date. The contribution by solar energy to the preheating of the domestic water has been much less than that predicted by an f-chart analysis of the system as installed. The disagreement between experience and the f-chart model seems to be principally because of poor heat exchanger effectiveness and reverse thermal stratification in the preheat tank. It may be that drain-back or drain-down systems would be more effective than closed loop collection systems.

(Author)

**A79-31438 Economic design of a solar domestic water heating system.** G. K. Yuill (UNIES, Ltd., Winnipeg, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 1. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 9 p. Research supported by the National Research Council of Canada.

The described investigation had the objective to minimize the cost of a solar domestic water heating system designed to supply 50% of the energy required to heat the domestic hot water for a ten unit townhouse in Winnipeg. The townhouse will have a central mechanical equipment room where the solar energy equipment will be installed. The preheated water from the solar energy system will be fed into conventional gas fired domestic water heaters in the ten housing units. Aspects of computer program development for the optimization study are considered. The investigation showed that for a domestic water heating system, there is a physical optimum tank size. This is not true for space heating systems, for which system performance increases with tank size and the tank size is determined by an economic optimization. The cheapest of several single glazed collectors considered, was found to be the most cost effective. G.R.

**A79-31439 WATSUN - A simulation program for solar-assisted heating systems.** M. Chandrashekar, K. G. T. Hollands, N. T. Le (Waterloo, University, Waterloo, Ontario, Canada), and J. F. Orgill (Ministry of Energy, Ontario, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 1. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 12 p. Research supported by the National Research Council of Canada and Canadian Electrical Association.

WATSUN is a computer program, written in Fortran IV, designed to evaluate the economic and technical performance of different solar space heating designs. The original version of WATSUN is capable of simulating three types of solar heating systems, including a liquid base system with short term storage, an air base system with short term storage, and a liquid base system with long term seasonal storage. A revised version of WATSUN, called WATSUN-II, has also been developed for simulation of solar assisted heat pump systems. Models of six different solar assisted heat pump systems are added to the program. Details of the program organization, component models, system configurations, and performance indices are briefly discussed. G.R.

**A79-31440 Validation of an electric circuit model of a solar house.** R. D. McConnell (IREQ, Varennes, Quebec, Canada), R. G. Kerr, and M. M. Shapiro (Concordia University, Montreal, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 1. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 12 p. 12 refs.

Meteorological, electrical and temperature measurements were recorded at fifteen minute intervals during the 1976-77 heating season in a solar house located near the village of La Macaza, Québec. A computer model was developed which simulates the house and its solar heating system. Thermal resistances are modelled by electric resistors, solar radiation by a current source, temperatures by electric voltages and thermal storage units by electric capacitors. A validation of the electric circuit model is described in which the responses of the model, to incident solar radiation, ambient temperature, and internal heat generation data, are compared with the recorded temperatures in the collector, in the solar storage unit and in the house, during four-day periods in February, 1977. Reasonable agreement is found. (Author)

**A79-31441 Mathematical modelling of passive solar systems.** C. Carter (Trent University, Peterborough, Ontario, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 1. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 12 p. 6 refs.

Calculations of heat gains and losses in buildings invariably use a linear approximation, usually without explicit mention of the fact. Actually, of course, both convection and radiation are nonlinear effects. The standard method of calculating heat losses for active solar collectors due to Duffie and Beckman (1974) treats the convective and radiative losses as nonlinear effects, and uses an iterative approach to obtain the temperatures and heat flows in various parts of the collector. In practice, the second iteration usually produces only a small correction to the first values calculated, thus indicating that a quasi-linear approximation might be adequate in most cases. For passive solar systems, the smaller temperatures would make a linear approximation even more reliable. Attention is given to the development of various other simplifications which follow once a linear approximation is adopted. G.R.

**A79-31442 Control system for solar hot water system.** M. J. Lesperance, R. M. Tomita, and S. Cadieux (Atelier Solaire Enrg., Pointe Claire, Quebec, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 1. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 7 p.

Although the solar energy industry is relatively young, it has a certain maturity through the industries which service it. One of these industries is the process control industry. In order that the solar industry benefits from the experience acquired by the process control industry, it is essential to apply the accepted standard practices. The processes found in a solar energy heliothermal system are comparable in their simplest form to a heat exchange loop where the sun is the heat source. The variables to control include temperatures, flows, and pressures. The common practices in the process control industry are examined, taking into account the application of these practices to the solar energy industry and, particularly, to hot water heating systems using fixed flat plate collectors. G.R.

**A79-31443 Solutions to energy conservation in northern climates.** E. J. Tymura (Tymura Solar designs, Thunder Bay, Ontario, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 1. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 14 p. 14 refs.

In connection with the limitation of fossil fuels, it is imperative that architectural designs evolve to conserve energy through the development of energy efficient buildings. Principles and advantages of terraculture, passive solar heating, active solar water heating, and regional climatic considerations have been coordinated to govern the design of a working solution to these present and future architectural concerns. Attention is given to design in response to the environment, various approaches for energy conservation, and the implementation of these approaches in a solar heated residence. G.R.



**A79-31444** Passive solar heating - Results from two Saskatchewan residences. R. S. Dumont, R. W. Besant (Saskatchewan, University, Saskatoon, Canada), G. Jones (Botting and Associates, Ltd., Saskatoon, Canada), and R. Kyle (Aquitaine of Canada, Ltd., Rainbow Lake, Alberta, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 1. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 17 p. 13 refs.

A description is presented of two houses incorporating design principles of passive solar heating. The dwellings were completed in the winter of 1977-78, one located in Saskatoon and the second in Regina. Performance tests on the houses were conducted in the spring of 1978. Both of the dwellings were of a direct gain type, with southerly oriented windows and no vertical thermal mass such as a concrete wall behind the windows. The performance tests show that passive solar heating can contribute a large fraction of the heating requirements. For the Regina residence, the contribution of passive gains should amount to 44% of the heating requirement during the heating months. Thermal shutters can be of significant value in reducing both the heat loss from dwellings and in moderating the temperature falls at night in well insulated dwellings. G.R.

**A79-31445** Measured and modeled passive performance in Montana. L. Palmiter, W. Caswell, and R. J. Corbett (National Center for Appropriate Technology, Butte, Mont.). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 1. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 9 p.

Several passive solar test units have been constructed at The National Center for Appropriate Technology. The design, instrumentation and performance of the direct gain and Trombe wall cells are discussed. Preliminary results of a simple computer model for simulating air and storage wall temperatures are presented. (Author)

**A79-31446** Integration of a passive and active solar heating system in a low density, multiple dwelling with atrium. T. G. Lee (Calgary, University, Calgary, Alberta, Canada) and D. H. Jenkins (Bilbrouck Partnership, Calgary, Alberta, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 1. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 14 p.

The considered passive heating principle involves the capture of solar energy in a glazed atrium court utilizing the 'greenhouse' principle. The heat generated by the atrium in excess of its own requirements is used to provide direct heat to the units, provide partial heat, supplemented by a conventional gas fired forced air system, and provide short term heat storage by drawing the excessive heat into a rock storage, to be later reused. Solar radiation passes through the glazing of the atrium to heat the space within. An insulating shutter will cover the atrium during the evenings or periods of prolonged cloudiness to prevent heat loss. G.R.

**A79-31447** The honeycomb heat trap - Its application in flat plate solar collectors. D. Hart (Watershed Energy Systems, Ltd., Toronto, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 2. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 10 p.

It is pointed out that a collector operating under Canadian midwinter conditions loses the major portion of its energy back through the covers and sides to the outside air. The primary mechanisms for this heat loss are examined along with the approaches used to reduce the effectiveness of these mechanisms. It is found that very few collector designs incorporate any means for suppressing free convection, which is the major source of heat loss. One such collector is the evacuated-type collector. A description is presented of another approach involving the use of honeycomb cells to suppress convection. It was found that by partitioning the air layer between the hot and cold surfaces, convective motion could be virtually eliminated. In a comparison of the performance of various solar collectors it was found that honeycomb panels provided 61.7%

of the annual heating load for a house, while air collectors of the same area supplied only 44.2% of the load. G.R.

**A79-31448** Cylindrical parabolic collector optimization for interfacing with steam turbine generators. M. G. Psogianakis and E. G. Plett (Carleton University, Ottawa, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 2. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 6 p.

An investigation is conducted regarding the feasibility to generate electricity using a steam cycle with the steam generated in a solar collector. Steam generation in a flat plate collector is possible, but its collecting efficiency becomes unattractively low at the high fluid temperature range required to generate steam. For this reason, a focussing collector shows promise of being a more viable means of generating steam. A hypothetical plant to use solar-thermally generated steam to generate electricity takes in water in the 90 to 100 C range, it is pressurized to 20 to 30 bars and then passed through the solar collector in which it is converted to steam at about 400 C. The steam is expanded in a conventional turbine which drives an electrical generator. The feasibility of such a system depends on the design, operation, and economics of the solar collector. The technical aspects of collector optimization are examined, taking into account the use of a cylindrical parabolic reflector. G.R.

**A79-31449** Sensible heat storage for solar energy applications. R. K. Romak and P. P. Von Hatten (Western Ontario, University, London, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 2. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 8 p.

In the field of solar energy, rocks are the most commonly used media for sensible heat storage. The use of other solid materials has not been adequately considered. This paper studies a group of eight selected materials. These include three sizes of rocks, clay balls, broken drainage tile, brick rubble, iron oxide pellets and blast furnace slag. Initially the materials' properties were analyzed. This was based on size, shape, density and thermal characteristics of the materials. Each material was then tested. A model heat storage unit was constructed to perform heating, cooling and pressure drop tests. These results combined with costs produced the material most suitable. It was found that the ideal material consists of small particles, has high density and heat capacity and packs with a small void ratio. The 3/4 in. stone was selected as most suitable. (Author)

**A79-31450** The first year of solar collector testing at Ontario Research. R. W. Bertram and G. Norgate (Ontario Research Foundation, Mississauga, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 2. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 16 p. 8 refs.

**A79-31451** Studies on solar collector performance at NRC. S. J. Harrison and J. R. Sasaki (National Research Council, Div. of Building Research, Ottawa, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 2. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 12 p. 8 refs.

As part of NRC's responsibility for the development of solar heating standards and test methods, a facility has been established at the Division of Building Research (DBR) to obtain data on the thermal performance and durability of solar collectors. A variety of solar collectors are being tested to determine the factors that affect their performance and life. A review of testing procedures is underway to assess their suitability for use in Canada. This paper describes the solar calorimeter apparatus and the in-house activities currently being pursued at DBR. (Author)

**A79-31452** Statistical analysis of solar radiation data in Montreal for solar energy utilization. C. Gueymard, D. Labelle, E.

Bilgen, and F. Laframboise (Ecole Polytechnique, Montreal, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 2. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 13 p. 7 refs.

**A79-31453** First year performance data and lessons learned in the NRC 14 house solar demonstration program. W. E. Carscallen and B. E. Sibbitt (National Research Council, Div. of Building Research, Ottawa, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 2. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 14 p.

**A79-31454** Alternate energy installations on the Jordan College Campus. L. K. Coxon (Jordan College, Cedar Springs, Mich.). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 2. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 8 p.

The considered energy installations include a flat plate air system that stores its solar heat in rocks, a flat plate drain down solar system for space heating and domestic hot water that stores its heated liquid in tanks, and a drain down do-it-yourself domestic water system using flat plate collectors. Attention is also given to a do-it-yourself air system that stores its heat in rocks and a concentrating high temperature liquid solar system for space heating, domestic hot water, and cooling. A solar greenhouse is also considered along with photovoltaic collectors for electricity generation and a wind energy conversion system for electricity generation. G.R.

**A79-31455** A hybrid wind turbine suitable for developing regions. E. Bilgen, I. Paraschivoiu, and M. Kaine (Ecole Polytechnique, Montreal, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 2. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 6 p. 5 refs.

In this article, a study is presented on a hybrid wind turbine which consists of two vertical axis coaxial turbines, one of Savonius type and the other a screw type. The Savonius type turbine rotates in a uniform velocity field while the second, the screw type converts the kinetic energy of the vortex flow generated in the center of the first turbine. Theoretically, it is shown earlier that the total efficiency of such a hybrid wind turbine can have a higher efficiency compared to that obtained from a simple system and the simplicity of the Savonius for manufacturing and maintenance of the system is retained. A model has been built to study the overall performance of this system, the results of which will serve to design and build a prototype hybrid turbine for the Northern regions of Quebec.

(Author)

**A79-31456** Determination of the potential for solar retrofitting in Edmonton. J. F. McLaughlin (Solar Energy Society of Canada, Inc.; Alberta, University, Edmonton, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 2. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 12 p.

The paper focuses on the methodology adopted for a pilot study which is currently being undertaken in Edmonton to determine the potential for adding active solar energy systems onto existing single family dwellings. Of particular importance is the sampling procedure, and the field methods utilized. Preliminary results and analysis are presented for one of the four neighborhoods selected for surveying. This neighborhood, Garneau, was constructed during the period 1946 to 1959. While over one half of the homes in the Garneau sample have south-facing roofs, many of these have limited or poor retrofit potential for roof collectors due to construction and shading problems. Alternative collector locations on the properties are also briefly discussed. The technical problems of mounting solar panels onto existing structures and integrating the 'solar assist system' into

conventional hot water and space heating systems are presented in chart form. (Author)

**A79-31457** Solar heating of domestic hot water at the Confederation Heights Cafeteria. D. H. Hampton and T. Lefeuve (Public Works Canada, Ottawa, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 2. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 9 p.

**A79-31458** P.E.I. solar assisted domestic water heat project. C. K. Brown (Institute of Man and Resources, Charlottetown, Prince Edward Island, Canada). In: Renewable alternatives; Proceedings of the Fourth Annual Conference, London, Ontario, Canada, August 20-24, 1978. Volume 2. Winnipeg, Solar Energy Society of Canada, Inc., 1978. 10 p.

**A79-31510** The influence of fuel composition on smoke emission from gas-turbine-type combustors - Effect of combustor design and operating conditions. N. J. Friswell (Shell Research, Ltd., Thornton Research Centre, Chester, England). *Combustion Science and Technology*, vol. 19, no. 3-4, 1979, p. 119-127. 9 refs.

The influence of fuel composition on smoke emission/combustor wall temperatures has been studied in a laboratory-scale gas-turbine-type combustor over the range of operating conditions of modern turbine combustors and as a function of combustor design. Fuel hydrogen content is shown to give the best prediction of smoke emission and of variations in flame tube wall temperature caused by changes in flame radiation. The major finding is that the influence of fuel composition on smoke emission/flame radiation falls virtually to zero at combustor pressure above about 10 bar. Significant reduction in sensitivity to fuel composition can also be obtained by varying combustor design and are tentatively correlated with increasing combustion intensity. The implication of these effects for aircraft operation is discussed and an explanation for the results is put forward based on changes in the chemical mechanisms leading to soot formation. (Author)

**A79-31554** A numerical model investigation of tidal phenomena in the Bay of Fundy and Gulf of Maine. D. A. Greenberg (Environment Canada, Marine Environmental Data Services Branch, Ottawa, Canada). *Marine Geodesy*, vol. 2, no. 2, 1979, p. 161-187. 21 refs.

A numerical model is developed to examine tidal properties of the Bay of Fundy and Gulf of Maine. The model is run with a pure M2 tidal input on the open boundary, and calibrated by adjusting the friction coefficient to achieve good agreement with inshore observations. An examination of aspects of the tidal regime is made, with particular attention paid to the upper reaches of the bay. Mean energy and work values are computed. The fundamental period of the system is estimated. The effects of tidal power plants on the tidal regime are examined. (Author)

**A79-31615 #** Dynamics of stepping of the Hermes flexible solar array. D. M. Gossain (Spar Aerospace, Ltd., Toronto, Canada). *Canadian Aeronautics and Space Journal*, vol. 25, 1st Quarter, 1979, p. 50-60.

The Communications Technology Satellite 'Hermes', in synchronous orbit since February 1976, is a 3-axis stabilized spacecraft, with the drive and track mechanisms rotating the base of the solar array at 0.25 deg every minute, in two 'steps' of 0.125 deg each. Dynamics anomalies encountered in array-stepping during the design of the system are described, together with a presentation of the analysis involving modelling the dynamic characteristics of the system using inertia, spring and dash-pot elements and simulation on a digital computer. Results of the analysis are discussed, with attention given to nominal stepping, fast-slew, and final design. It is indicated that the fast-slew mode can become unstable for some pulse-widths, with the width of the unstable zones depending on the energy dissipation characteristics. Increasing damping is shown to reduce the width of the unstable zones. A.A.

**A79-31754** Plasma behavior near the neutral line between parallel currents. G. G. Zukakishvili, I. F. Kvartskhava, and L. M. Zukakishvili (Akademiia Nauk Gruzinskoi SSR, Fiziko-Tekhnicheskii Institut, Sukhumi, Georgian SSR). (*Fizika Plazmy*, vol. 4, July-Aug. 1978, p. 725-734.) *Soviet Journal of Plasma Physics*, vol. 4, July-Aug. 1978, p. 405-410. 19 refs. Translation.

Experiments on the plasma behavior in planar Z pinches are described. The initial stage of the discharge leads to the formation of two current filaments that are separated by a magnetic-field neutral line. The filaments move toward each other. As a result of the motion of the original filaments, new regions of enhanced particle density (secondary filaments) appear in the intermediate plasma, and the return current flows through them. The electric field is calculated near two parallel moving currents. When the conductors are moving in opposite directions, an induced electric field appears between them; this electric field is antiparallel to the currents in the conductors. The total electric field in the neutral region of a system of linear parallel currents can be higher than the applied electric field in the moving conductors, and if the particle density is low, a stream of fast accelerated charged particles can appear in this region.

(Author)

**A79-31760** Relaxation of a fast ion beam in a tokamak plasma. V. M. Bardakov (Akademiia Nauk SSSR, Institut Zemnogo Magnetizma, Ionosfery i Rasprostraneniia Radiovoln, Irkutsk, USSR). (*Fizika Plazmy*, vol. 4, July-Aug. 1978, p. 789-798.) *Soviet Journal of Plasma Physics*, vol. 4, July-Aug. 1978, p. 443-448. 16 refs. Translation.

The quasi-linear relaxation of a fast ion beam due to unstable Alfvén waves is analyzed in connection with the problem of a calculation of the thermonuclear efficiency (Q) of a two-component tokamak fusion reactor. If the quasi-linear relaxation is assumed to occur instantaneously, the thermonuclear Q is lower than the classical value, calculated for purely Coulomb relaxation of the beam, by an average of a factor of five. Magnetic shear causes a nearly instantaneous quasi-linear relaxation by stable Alfvén noise in the absence of shear to convert into a slow diffusive spreading of the beam distribution function. This spreading comes to a halt in a time comparable to the characteristic Coulomb time. The local value of Q falls off significantly in this case only near the center of the plasma column, where the shear is small. Q averaged over the column, on the other hand, decreases by only a few percent from the classical value if the beam density does not have a maximum at the center of the plasma column.

(Author)

**A79-31762** Experiments on controlling the plasma density in the TO-1 tokamak. L. I. Artemenkov, E. V. Grodzinskii, N. V. Ivanov, A. M. Kakurin, and V. S. Svishchev (Akademiia Nauk SSSR, Institut Atomnoi Energii, Moscow, USSR). (*Fizika Plazmy*, vol. 4, July-Aug. 1978, p. 812-817.) *Soviet Journal of Plasma Physics*, vol. 4, July-Aug. 1978, p. 457-460. 8 refs. Translation.

Experiments on neutral-gas injection into the chamber of the TO-1 tokamak are described. The gas inlet valve is controlled by a predetermined program or automatically as a function of the time evolution of the MHD activity of the discharge. The density can be adjusted over a broad range by adjusting the gas injection. The rate of increase of the relative MHD activity is studied as a function of the discharge characteristics. Certain plasma properties are measured during the injection. With automatic control of the inlet valve the plasma density can be increased substantially and held at the new level throughout most of the discharge pulse in the tokamak.

(Author)

**A79-31763** Calculation of the Q factor for a two-component tokamak. V. M. Bardakov and V. I. Pistunovich (Akademiia Nauk SSSR, Institut Atomnoi Energii, Moscow, USSR). (*Fizika Plazmy*, vol. 4, July-Aug. 1978, p. 818-821.) *Soviet Journal of Plasma Physics*, vol. 4, July-Aug. 1978, p. 460-462. 9 refs. Translation.

The extent to which mutual collisions of deuteron-beam particles affect the ion distribution and Q factor of a two-component tokamak is considered, along with the sufficiency of a quasi-linear approximation in which mutual collisions of beam particles are ignored but the effect of the beam on the background plasma is taken into account. The evolution of a two-component tokamak system is examined on the assumption that the plasma energy lifetime is long. The results indicate that the Q factor for models more complicated than the two-component tokamak can be calculated by solving the cited quasi-linear problem. The error in determining the Q factor is shown to be no more than 5% in comparison with the exact nonlinear problem.

F.G.M.

**A79-31764** Heat transport near the wall of a tokamak reactor. V. G. Petrov and M. Z. Tokar (Akademiia Nauk SSSR, Institut Vysokikh Temperatur, Moscow, USSR). (*Fizika Plazmy*, vol. 4, July-Aug. 1978, p. 822-825.) *Soviet Journal of Plasma Physics*, vol. 4, July-Aug. 1978, p. 462, 463. 9 refs. Translation.

The region near the wall in which the plasma interacts with neutral atoms is studied. The kinetic equation with charge exchange and ionization is solved for the neutrals. The plasma is described hydrodynamically because the gyroradii are small. The calculated results are the distributions of the plasma and neutral gas properties near the wall.

(Author)

**A79-31765** A scheme for direct conversion of plasma thermal energy into electrical energy. A. V. Timofeev (Akademiia Nauk SSSR, Institut Atomnoi Energii, Moscow, USSR). (*Fizika Plazmy*, vol. 4, July-Aug. 1978, p. 826-834.) *Soviet Journal of Plasma Physics*, vol. 4, July-Aug. 1978, p. 464-468. 9 refs. Translation.

A recovery device is described for implementing a scheme whereby the thermal energy of a plasma is directly converted into electrical energy as the charged plasma particles drift in a region of crossed electric and inhomogeneous magnetic fields. An energy-recovery principle is outlined which involves the use of magnetic mirrors and the electrical contact between the plasma confined in the recovery device and electrodes located beyond the mirrors. Problems associated with plasma stability, plasma contact with the end electrodes, and plasma injection into the recovery device are considered. Properties of the proposed recovery device are compared with those of the Post device, which consists of an expander and a collector.

F.G.M.

**A79-31766** Dynamic stabilization of toroidal discharges in weak longitudinal magnetic fields. I. M. Roife, M. A. Vasilevskii, and E. V. Seredenko (Nauchno-Issledovatel'skii Institut Elektrofizicheskoi Apparatury, Leningrad, USSR). (*Fizika Plazmy*, vol. 4, July-Aug. 1978, p. 835-841.) *Soviet Journal of Plasma Physics*, vol. 4, July-Aug. 1978, p. 469-472. 19 refs. Translation.

Experiments on the production of a stable plasma column with  $q$  less than unity in the TT-3 and Toloskop devices are reported. The experiments were carried out to create a stable hot (highly conducting) plasma capable of producing stable magnetic-column conditions in fusion devices of the Zeta and Alpha types. The stability was studied by a dynamic-stabilization method with high-frequency modulation of the approximately steady discharge current. It is concluded that the observed suppression of the MHD instability with  $m = 1$  is due to the combined effects of the induced currents in the conducting wall and the radial magnetosonic plasma waves that are excited. With a 'clean' vacuum chamber, it is possible in this case to achieve stable operation for discharges in fusion devices like Zeta and Alpha.

(Author)

**A79-31845** Combustion of hydrogen in a supersonic flow in a channel in the presence of a pseudodiscontinuity. V. L. Zimont, V. M. Levin, and E. A. Meshcheriakov. (*Fizika Goreniia i Vzryva*, vol. 14, July-Aug. 1978, p. 23-36.) *Combustion, Explosion, and Shock Waves*, vol. 14, no. 4, Jan. 1979, p. 424-435. 17 refs. Translation.

Hydrogen combustion in a supersonic channel flow in the presence of an extended region of transition from supersonic to subsonic flow (a pseudodiscontinuity) is investigated experimentally and numerically. Experimentally determined pressure distributions show the presence of combustion to lessen the increase of pressure associated with a pseudodiscontinuity formed by flow throttling in a channel of variable cross section. In a cylindrical channel, a reduction of the excess oxidant factor or the stagnation temperature of the oxidant leads to an upstream displacement of the zone of pressure increase, indicating more complete combustion. A flow model based on the integral method of calculating the pseudodiscontinuity in the channel is derived with the addition of jet and wake mixing factors, to account for combustion heat release. Results of model calculations of pressure and Mach number distributions are shown to agree well with experimental values. A.L.W.

**A79-31908** Energy and aerospace; Proceedings of the Anglo/American Conference, London, England, December 5-7, 1978. Conference sponsored by the Royal Aeronautical Society and American Institute of Aeronautics and Astronautics. London, Royal Aeronautical Society, 1979. 336 p. \$35.

The energy research and development program of the U.S. is considered along with aspects of energy research and development on the basis of a UK view, prospects for reducing the fuel consumption of civil aircraft, the NASA aircraft energy efficiency program, aviation fuel from coal, commercial transports in the 1980s, the impact of aeronautical sciences on other modes of transport, and oil exploration from space. Attention is also given to the design and application of large wind turbine generators, off-shore multi-MW wind turbine system development as key to cost-effective wind energy for Sweden, a review of some critical aspects of satellite power systems, a preliminary assessment of the environmental impact of satellite power systems, European aspects of solar satellite power systems, and photovoltaics and solar thermal power systems. G.R.

**A79-31909** # The Energy Research and Development Program of the United States. D. D. Myers (U.S. Department of Energy, Washington, D.C.). In: Energy and aerospace; Proceedings of the Anglo/American Conference, London, England, December 5-7, 1978. London, Royal Aeronautical Society, 1979. 11 p.

The world energy system is considered along with the situation in the U.S., the national energy act, the progress achieved in the U.S. with respect to the conservation of energy, aerospace experience which is applicable to the solution of energy problems, and aspects of organization for research and development. Attention is given to work conducted in the area of central solar technology, photovoltaics, wind turbines, fuel cells, the breeder reactor, fusion, and the solar power satellite. G.R.

**A79-31910** # Energy research and development - A U.K. view. H. Bondi (Department of Energy, London, England). In: Energy and aerospace; Proceedings of the Anglo/American Conference, London, England, December 5-7, 1978. London, Royal Aeronautical Society, 1979. 8 p.

Developments in the UK related to energy conservation are examined, taking into account the approaches for an economic use of energy which can be provided by aerospace technology and, in particular, solid state electronics. Attention is also given to the employment of offshore technology to gain hydrocarbon resources from below the sea, research and development which is being carried out by the energy supply industries, developments in the nuclear field, the utilization of wave energy, the solar energy program, a use of geothermal energy, the significance of tidal energy, and aspects of cogeneration. G.R.

**A79-31911** Prospects for reducing the fuel consumption of civil aircraft. G. G. Pope (Royal Aircraft Establishment, Farn-

borough, Hants., England). In: Energy and aerospace; Proceedings of the Anglo/American Conference, London, England, December 5-7, 1978. London, Royal Aeronautical Society, 1979. 21 p. 10 refs.

An outline is provided of technological advances that will contribute to the reduction of fuel consumption. Attention is concentrated mainly on advances being made in the UK. The emphasis is on developments that can be exploited in the generation of aircraft which will succeed the more recent of the transport aircraft types now in service and those which will reach the airlines in the early 1980s. Advances in powerplants are examined along with developments in aerodynamics, taking into account advances in design techniques, experimental facilities, wing tip design, drag reduction, and laminar flow control. Attention is also given to materials and structures, active control technology, and operational considerations. G.R.

**A79-31912** \* # The NASA Aircraft Energy Efficiency program. J. M. Klineberg (NASA, Washington, D.C.). In: Energy and aerospace; Proceedings of the Anglo/American Conference, London, England, December 5-7, 1978. London, Royal Aeronautical Society, 1979. 19 p.

A review is provided of the goals, objectives, and recent progress in each of six aircraft energy efficiency programs aimed at improved propulsive, aerodynamic and structural efficiency for future transport aircraft. Attention is given to engine component improvement, an energy efficient turbofan engine, advanced turboprops, revolutionary gains in aerodynamic efficiency for aircraft of the late 1990s, laminar flow control, and composite primary aircraft structures. G.R.

**A79-31913** # Aviation fuels from coal. J. Gibson (National Coal Board, London, England). In: Energy and aerospace; Proceedings of the Anglo/American Conference, London, England, December 5-7, 1978. London, Royal Aeronautical Society, 1979. 16 p.

Although the ultimate aviation fuel may prove to be liquid hydrogen produced from water by electrolysis using nuclear power, there are powerful arguments to continue to use hydrocarbon fuels and as much as possible of the infrastructure associated with them. In effect, the objective must be to bridge the gap until reliance can shift to nuclear-based fuel and that is still far off. Attention is given to the world fuel reserves, the demand for aviation fuel, the principles of coal liquefaction, conventional and unconventional aviation fuels from coal, coal liquefaction processes, and possible alternative strategies. The current status and potential for aviation fuels from coal are considered and the UK program on coal liquefaction is discussed. G.R.

**A79-31915** # The impact of aeronautical sciences on other modes of transport. I. C. Cheeseman (Southampton, University, Southampton, England) and A. H. Wickens (British Railways Research and Development Div., London, England). In: Energy and aerospace; Proceedings of the Anglo/American Conference, London, England, December 5-7, 1978. London, Royal Aeronautical Society, 1979. 22 p.

The development of theories and numerical methods appears to represent the greatest impact of aeronautical science on the other modes of transport. The energy characteristics of air, rail, and road transport are examined. The effect of fuel costs on the overall operating costs are greatest in the case of aircraft. This means that the operating price increase which can be accepted in order to improve fuel economy is lower for road and rail than for air. Although the problems which have to be solved in the three modes are similar, for example, reduced weight, lower aerodynamic drag, and improved prime mover efficiency, solutions which are acceptable for aircraft do not generally apply to the other modes. The gas turbine which predominates in industry has attractions for the other modes. However, rail electrification offers much greater gains and at the same time makes that form of transport less dependent on oil-based fuels. G.R.

**A79-31916 #** Design and application of large wind turbine generators. D. F. Warne (Electrical Research Association, Ltd., Leatherhead, Surrey, England). In: Energy and aerospace; Proceedings of the Anglo/American Conference, London, England, December 5-7, 1978. London, Royal Aeronautical Society, 1979. 15 p. 12 refs.

An outline is provided of several national programs which are concerned with the construction of new machines for the utilization of wind energy. General factors governing economics are examined, taking into account the importance of wind speed, the importance of scale, and the rate of machine output. Design choices in large wind turbine generators are also discussed, giving attention to design decisions related to turbine type, the turbine diameter, aspects of pitch control, the number of blades, the choice of fixed or variable turbine speed, the significance of upwind or downwind location as a design option, and the general question of system stiffness. G.R.

**A79-31917 #** Off-shore multi-MW size wind turbine system development is the key to cost-effective wind energy for Sweden. O. Ljungstrom (Forsvarsdepartementet, Flygtekniska Forsoksanstalten, Bromma, Sweden). In: Energy and aerospace; Proceedings of the Anglo/American Conference, London, England, December 5-7, 1978. London, Royal Aeronautical Society, 1979. 13 p. 6 refs.

**A79-31918 #** The JET project - A step towards the production of power by nuclear fusion. A. Gibson. In: Energy and aerospace; Proceedings of the Anglo/American Conference, London, England, December 5-7, 1978. London, Royal Aeronautical Society, 1979. 15 p.

JET is to be a large tokamak experiment designed to take advantage of some recent advances and to set the stage for the construction of a future fusion reactor experiment. The objective of the JET experiment is to obtain and study a plasma in conditions and with dimensions which approach those needed in a fusion reactor. The realization of this objective involves four main areas of work which are related to the study of the scale-up of the confinement properties, the study and control of plasma-wall interaction and impurity influx, the demonstration of effective heating techniques, and an operation in conditions where alpha-particles from deuterium-tritium reactions are produced and confined. G.R.

**A79-31919 #** Status of the SPS concept development and evaluation program. F. A. Koomanoff (U.S. Department of Energy, Satellite Power Systems Projects Office, Washington, D.C.). In: Energy and aerospace; Proceedings of the Anglo/American Conference, London, England, December 5-7, 1978. London, Royal Aeronautical Society, 1979. 17 p.

The Satellite Power System (SPS) is designed to capture solar radiation in geosynchronous orbit and, by means of photovoltaics, convert the solar energy to electrical energy. The current status of the SPS program is discussed by describing the systems definition activities, environmental and societal assessment activities, and the comparative assessment directions. The organization and funding for these activities are also presented. It is concluded that to date no program stoppers have been found, however, many significant questions remain unanswered; questions which must be answered before the next steps may be reached in determining if SPS is indeed an energy option for mankind. G.R.

**A79-31920 #** Solar Power Satellite systems definition. G. R. Woodcock (Boeing Aerospace Co., Seattle, Wash.). In: Energy and aerospace; Proceedings of the Anglo/American Conference, London, England, December 5-7, 1978. London, Royal Aeronautical Society, 1979. 47 p.

A summary is provided of the results obtained in a detailed investigation of the technical and cost feasibility of Solar Power Satellites (SPS). Attention is given to SPS configuration options, the

photovoltaic energy conversion, a recommended gallium arsenide satellite concept, the radiation degradation of solar cells, questions of power distribution, microwave power transmission, microwave generation technology, phase control, the power receiver system, ground-based power processing technology, laser power transmission, space transportation to low earth orbit, space-based construction and transportation operations, costing methods, cost analysis methodology, SPS cost ranges, economic analyses, resources requirements, and aspects of development and implementation. G.R.

**A79-31921 #** A review of some critical aspects of satellite power systems. I. V. Franklin (British Aerospace, Dynamics Group, Weybridge, Surrey, England) and A. W. Rudge (Electrical Research Association, Ltd., RF Technology Centre, Leatherhead, Surrey, England). In: Energy and aerospace; Proceedings of the Anglo/American Conference, London, England, December 5-7, 1978. London, Royal Aeronautical Society, 1979. 18 p. 13 refs.

Some critical aspects of the Solar Power Satellite (SPS) are considered. The basic concepts of the SPS are considered along with aspects of SPS delivery and construction systems, solar arrays, on board electrical power collection, costs, European activities, and questions of development strategy. The SPS microwave system is examined, taking into account basic operations and constraints, the baseline microwave system, major areas of uncertainty, and the space antenna. G.R.

**A79-31922 #** Preliminary assessment of the environmental impacts of the Satellite Power System (SPS). S. L. Halverson, D. M. Rote (Argonne National Laboratory, Argonne, Ill.), C. M. Rush (National Telecommunications and Information Administration, Institute for Telecommunication Sciences, Boulder, Colo.), K. Davis (Battelle Pacific Northwest Laboratories, Richland, Wash.), M. White (California, University, Berkeley, Calif.), and D. F. Cahill (U.S. Environmental Protection Agency, Research Triangle Park, N.C.). In: Energy and aerospace; Proceedings of the Anglo/American Conference, London, England, December 5-7, 1978. London, Royal Aeronautical Society, 1979. 17 p.

Investigations required to assess the health and ecological effects of microwaves are considered. In addition to the impacts of microwaves, a number of other health and safety effects can be anticipated from the deployment of a Solar Power Satellite (SPS). Factors that are unique to the SPS deployment are related to the handling of large quantities of gallium arsenide for solar cells and the exposure of construction workers to extended periods of space radiation. Attention is also given to the effects on the atmosphere, aspects of electromagnetic compatibility, and ionospheric heating and vehicle effluent effects. G.R.

**A79-31923 #** European aspects of Solar Satellite Power systems. M. Trella and K. K. Reinhartz (ESA, Noordwijk, Netherlands). In: Energy and aerospace; Proceedings of the Anglo/American Conference, London, England, December 5-7, 1978. London, Royal Aeronautical Society, 1979. 17 p. 18 refs.

It is pointed out that energy-related problems are potentially much more serious in Europe than in the U.S. The proposal is, therefore, made that European countries should investigate the prospects offered by the SPS as a future source of a part of the energy needed by them. An outline is presented of the specifically European problems which have to be investigated to evaluate the SPS concept. Possible European activities are examined, taking into account a concept evaluation, studies related to energy conversion, space construction and operation, power transmission and distribution, transportation, and the selection criteria for technological research. Program considerations and financial aspects are also explored. G.R.

**A79-31924 \* #** Photovoltaics and solar thermal conversion to electricity - Status and prospects. M. E. Alper (California Institute of

Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In: Energy and aerospace; Proceedings of the Anglo/American Conference, London, England, December 5-7, 1978. London, Royal Aeronautical Society, 1979. 16 p. 16 refs.

Photovoltaic power system technology development includes flat-plate silicon solar arrays and concentrating solar cell systems, which use silicon and other cell materials such as gallium arsenide. System designs and applications include small remote power systems ranging in size from tens of watts to tens of kilowatts, intermediate load-center applications ranging in size from tens to hundreds of kilowatts, and large central plant installations, as well as grid-connected rooftop applications. The thermal conversion program is concerned with large central power systems and small power applications. G.R.

**A79-31925 \* #** The Solar Power Satellite concept - Towards the future. C. C. Kraft, Jr. (NASA, Johnson Space Center, Houston, Tex.). In: Energy and aerospace; Proceedings of the Anglo/American Conference, London, England, December 5-7, 1978. London, Royal Aeronautical Society, 1979. 12 p.

An evolutionary program phasing with respect to the development of a Solar Power Satellite (SPS) is considered, taking into account concept identification, concept evaluation, exploratory research, space technology projects, system development, and commercial operations. At the present time the concept evaluation phase of the program is underway. This phase is scheduled for completion in 1980. It will result in a recommendation as to whether the concept should be explored further and if so, in what manner. The recommendation will be based on technical feasibility, economic and environmental considerations, and comparisons with other potential systems of the future. It is premature to speculate on the conclusions and recommendations from the evaluation program as to whether the program should proceed to the next phase. G.R.

**A79-31951** Metallurgical coatings 1978; Proceedings of the Fifth International Conference, San Francisco, Calif., April 3-7, 1978. Volumes 1 & 2. Edited by R. F. Bunshah. Lausanne, Elsevier Sequoia, S.A. (*Thin Solid Films*, vol. 53-54, 1978), 1978. Vol. 1, 396 p.; vol. 2, 381 p. Price of two volumes, \$93.38.

Recent advances in protective metallurgical coatings for a variety of low-wear, low-corrosion, and high-temperature applications are discussed. Attention is focused on characterization of coatings, surface cleaning techniques, metallurgical aspects of microelectronics, coatings for gas turbine applications, and coatings for friction and wear. Other problem areas of interest include advances in PVD technology, refractory compound coatings, coatings for solar energy applications, and metal and alloy coatings (structure, properties and applications). The information presented serves as a sound basis for further developments. S.O.

**A79-31969** Selective-black absorbers using sputtered cermet films. J. C. C. Fan (MIT, Lexington, Mass.). In: Metallurgical coatings 1978; Proceedings of the Fifth International Conference, San Francisco, Calif., April 3-7, 1978. Volume 2. Lausanne, Elsevier Sequoia, S. A., 1978, p. 139-148. 14 refs. USAF-sponsored research.

Selective-black absorbers have high solar absorptivity and low infrared emissivity. Excellent selective-black absorbers are prepared by using RF sputtering to deposit MgO-Au and Cr2O3-Cr cermet films, which are highly absorbing in the solar spectrum and highly transparent in the infrared, on metal substrates. Both types of films are found to consist of individual crystallites less than 200 Å in size. Absorbers with solar absorptivity of over 0.9 and infrared emissivity of less than 0.1 have been prepared by depositing films of 75 vol% MgO-25 vol% Au on molybdenum-coated stainless steel. These absorbers are stable in air up to 400 C. Absorbers with similar optical properties have been obtained by depositing films of 71 vol% Cr2O3-29 vol% Cr on nickel-coated stainless steel, provided that

these films are covered with a Cr2O3 antireflection coating. These absorbers are stable in air up to 300 C. Computer calculations indicate that even better selective properties can be obtained by using Cr2O3-Cr films with a graded composition profile rather than a discrete Cr2O3 coating. (Author)

**A79-31970** Black germanium solar selective absorber surfaces. L. R. Gilbert, R. Messler, and R. Roy (Pennsylvania State University, University Park, Pa.). In: Metallurgical coatings 1978; Proceedings of the Fifth International Conference, San Francisco, Calif., April 3-7, 1978. Volume 2. Lausanne, Elsevier Sequoia, S. A., 1978, p. 149-157. 19 refs.

Semiconductor films with an appropriate bandgap (approximately 0.5-1.25 eV) have a high absorption coefficient in the solar spectral region and high transmission in the IR thermal emission region and thus make nearly ideal selective absorbers when coated on polished metal surfaces with low IR emittance. However, owing to their high refractive index, semiconductor films have high reflectance (approximately 45%) which limits their total solar absorption. It is shown that by controlling the sputtering preparation conditions of noncrystalline germanium films the surface microstructure can be drastically altered by simply etching in 30% H2O3. The resulting surface has a total reflectance of less than 3% in the solar spectrum. This flat-back surface appearance is shown to be due to a dense array of aligned needle-like protrusions which have an extremely high aspect ratio and both a cross-sectional area and a separation between needles of the order of the wavelength of solar radiation. (Author)

**A79-32103 #** The formulation of the wall stabilization problem of an axisymmetrical toroidal sharp-boundary plasma with a horizontally elongated noncircular cross section. T. Honma, M. Kaji, M. Seki (Hokkaido University, Sapporo, Japan), and M. Kito (Ministry of International Trade and Industry, Electrotechnical Laboratory, Tokyo, Japan). *Hokkaido University, Faculty of Engineering, Bulletin*, no. 93, 1979, p. 57-67. 10 refs.

The problem of the stability of an axisymmetric toroidal sharp-boundary plasma in a perfectly conducting toroidal wall. The cross section of the plasma is assumed to be horizontally elongated. The argument of the Wangerin functions is given exactly by both the aspect ratio and the elongation ratio of the toroidal geometry. Flat ring cyclide coordinates are introduced, and the equilibrium of the plasma in the flat-ring cyclide coordinates is studied under the assumption of uniform pressure confined only by surface currents. Critical poloidal beta's are obtained. P.T.H.

**A79-32105** Development of the combustion chamber of an experimental MHD generator. Ia. S. Zholudov (Akademii Nauk Ukrainskoi SSR, Institut Elektrodinamiki, Kiev, Ukrainian SSR). (*Teploenergetika*, Aug. 1978, p. 45-48.) *Thermal Engineering*, vol. 25, no. 8, 1978, p. 21-24. 8 refs. Translation.

The requirement placed on the combustion chamber of an MHD generator operating with nonpreheated fuel are formulated. A combustion chamber designed for gaseous fuel, which meets the formulated requirements is described. Particular attention is given to design solutions leading to an ordered spatial structure of the flow and a drastic decrease in fluctuations. V.P.

**A79-32139** Solar energy in developing countries: An overview and buyers' guide for solar scientists and engineers. A. Eggers-Lura (European Helio Centre, Gentofte, Denmark). Oxford, Pergamon Press, Ltd. (Pergamon European Heliostudies. Volume 1), 1979. 212 p. 1500 refs. \$40.

The book is an overview and buyers' guide for solar scientists and engineers on solar energy in developing countries. General information on solar activities of relevance for the developing countries is given, along with a review of the state of the art of solar energy applications in developing countries. Attention is directed to solar R&D work in these countries. Also provided is information on sources of literature, hardware and equipment, along with a detailed

**A79-32194**

bibliography (mostly with abstracts) that comprises about 2000 entries. S.D.

**A79-32194** Solar energy - Four sites demonstrate potential. T. Collins. *IEEE Spectrum*, vol. 16, Apr. 1979, p. 60-65.

Four solar energy demonstration units are described: a space-heating and hot-water facility for a school gymnasium in Iowa; a hot-water system retrofitted to a large commercial laundry in California; a system providing space heating and cooling to a small two-story office building in Florida; and a direct-gain type passive space heating facility for a warehouse in New Hampshire. Although none of the systems discussed here shows a high degree of cost-effectiveness, production-line manufacturing and mass marketing should help to cut costs. At present, the New Hampshire system would be competitive with electricity priced at 4.3 cents/kWh.

J.M.B.



## STAR ENTRIES

**N79-15932#** Centre National d'Etudes Spatiales, Toulouse (France).

### HIGH ACCURACY OFF-SHORE POSITION FINDING USING THE GEOLE SATELLITE BASED SYSTEM

Jean-Claude Husson and Jean Saint-Etienne Apr. 1977 16 p  
 Avail: NTIS HC A02/MF A01

Market studies conducted in 1971 and 1974 show that the number of potential users for high-precision position-fixing systems (i.e. ones offering an open sea accuracy of 100 to 200 m) was limited. The total number of ships requiring such services in the early 1990's can be estimated at 400. These ships will be highly specialized and well equipped; on board equipment will clearly include sophisticated dead reckoning systems (Doppler sonar, inertial unit, etc.) and computers. The GEOLE was designed as a means of periodically updating dead reckoning calculations performed onboard ships. To provide updating every 2 hours would require 4 satellites, each weighing 250 kg. These would be placed in orbits at an altitude of 1500 km inclined at 75 deg to the equator, with the four ascending nodes separated from one another by 45 deg of longitude. J.A.M.

**N79-15961\*#** National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

### THE ROTARY COMBUSTION ENGINE: A CANDIDATE FOR GENERAL AVIATION

1978 190 p refs Symp. held at Cleveland, Ohio, 28 Feb. 1978  
 (NASA-CP-2067; E-9800) Avail: NTIS HC A09/MF A01 CSCL 21A

The state of development of the rotary combustion engine is discussed. The nonturbine engine research programs for general aviation and future requirements for general aviation powerplants are emphasized.

**N79-15963\*#** National Aeronautics and Space Administration, Langley Research Center, Hampton, Va.

### GENERAL AVIATION ENERGY-CONSERVATION RESEARCH PROGRAMS

Edward A. Willis In *its* The Rotary Combust. Engine 1978 p 13-35 refs  
 Avail: NTIS HC A09/MF A01 CSCL 21A

A review is presented of nonturbine general aviation engine programs underway at the NASA-Lewis Research Center. The program encompasses conventional, lightweight diesel, and rotary engines. Its three major thrusts are: (1) reduced SFC's; (2) improved fuels tolerance; and (3) reducing emissions. Current and planned future programs in such areas as lean operation, improved fuel management, advanced cooling techniques, and advanced engine concepts, are described. These are expected to lay the technology base, by the mid to latter 1980's, for engines whose total fuel costs are as much as 30% lower than today's conventional engines. J.M.S.

**N79-15964\*#** Toyo Kogyo Co. Ltd., Hiroshima (Japan).

### DEVELOPMENT STATUS OF ROTARY ENGINE AT TOYO KOGYO

Kenichi Yamamoto In NASA, Lewis Res. Center The Rotary Combust. Engine 1978 p 37-84

Avail: NTIS HC A09/MF A01 CSCL 21A

Progress in the development of rotary engines which use a thermal reactor as the primary part of the exhaust emission control system is reviewed. Possibilities of further improvements in fuel economy of future rotary engines are indicated. J.M.S.

**N79-15965\*#** Audi NSU Auto Union A.G., Neckarsulm (West Germany).

### UPDATE OF DEVELOPMENT ON THE NEW AUDI NSU ROTARY ENGINE GENERATION

Richard vanBasshuysen In NASA, Lewis Res. Center The Rotary Combust. Engine 1978 85-107

Avail: NTIS HC A09/MF A01 CSCL 21A

Rotary engines with a chamber volume of 750 cc as a two rotor, automotive powerplant, called KKM 871 are described. This engine is compared to a 3 liter or 183 cubic inch, six-cylinder reciprocating engine. Emphasis is placed on exhaust emission control and fuel economy. J.M.S.

**N79-15966\*#** Audi NSU Auto Union A.G., Neckarsulm (West Germany).

### REVIEW OF THE RHEIN-FLUGZEUGBAU WANKEL POWERED AIRCRAFT PROGRAM

Manfred Riethmueller In NASA, Lewis Res. Center The Rotary Combust. Engine 1978 p 109-122

Avail: NTIS HC A09/MF A01 CSCL 21A

The development of light aircraft with special emphasis on modern propulsion systems and production is discussed in terms of the application of rotary engines to aircraft. Emphasis is placed on the integrated ducted-fan propulsion system using rotary engines. J.M.S.

**N79-15967\*#** Curtiss-Wright Corp., Wood-Ridge, N.J.

### ROTARY ENGINE DEVELOPMENTS AT CURTISS-WRIGHT OVER THE PAST 20 YEARS AND REVIEW OF GENERAL AVIATION ENGINE POTENTIAL

Charles Jones In NASA, Lewis Res. Center The Rotary Combust. Engine 1978 p 123-174 refs

Avail: NTIS HC A09/MF A01 CSCL 21A

The development of the rotary engine as a viable power plant capable of wide application is reviewed. Research results on the stratified charge engine with direct chamber injection are included. Emission control, reduced fuel consumption, and low noise level are among the factors discussed in terms of using the rotary engine in general aviation aircraft. J.M.S.

**N79-15968\*#** National Aeronautics and Space Administration, Langley Research Center, Hampton, Va.

### ENGINE REQUIREMENTS FOR FUTURE GENERAL AVIATION AIRCRAFT

Joseph W. Stickle In NASA, Lewis Res. Center The Rotary Combust. Engine 1978 p 175-186

Avail: NTIS HC A09/MF A01 CSCL 21A

The market place is examined for general aviation aircraft into the 1980's. The visible constraints that engine manufacturers must face regardless of the type of cycle are indicated. J.M.S.

**N79-16036\*#** Rockwell International Corp., Downey, Calif. Space Div.

### SATELLITE POWER SYSTEMS (SPS) CONCEPT DEFINITION STUDY. VOLUME 1: EXECUTIVE SUMMARY

#### Final Report

G. Hanley Apr. 1978 88 p 7 Vol.

(Contract NAS8-32475)

(NASA-CR-150700; SD-78-AP-0023-1-Vol-1) Avail: NTIS HC A05/MF A01 CSCL 22B

The evolution of a total satellite power is described as well as major subsystem alternatives. Trade study results are given for satellite concepts, ground receiving antennas, satellite construction sites, and transportation. Point design definition, end-to-end analysis, and programatics are covered. The GaAIs

photovoltaic concept is recommended as the current preliminary baseline satellite concept with silicon photovoltaic and Rankine cycle solar-thermal concepts as viable alternatives. Geosynchronous orbit is preferred for the construction of the satellite. A horizontal takeoff and landing air breathing rocket HLLV concept is preferred for earth-to-LEO transportation, with vertical takeoff options as viable alternatives. An argon electric orbit transfer vehicle is preferred for cargo transport from LEO and GEO orbit, and a chemical LH2/LO2, two-stage orbit transfer vehicle is recommended for crew transport. A stripline rectenna array is the current preferred concept. A.R.H.

**N79-16037\*** Rockwell International Corp., Downey, Calif. Space Div.

**SATELLITE POWER SYSTEMS (SPS) CONCEPT DEFINITION STUDY, VOLUME 2: SPS SYSTEM REQUIREMENTS Final Report**

G. Hanley Apr. 1978 93 p. 7 Vol.

(Contract NAS8-32475)

(NASA-CR-150681; SD-78-AP-0023-2-Vol-2) Avail: NTIS HC A05/MF A01 CSDL 22B

Collected data reflected the level of definition resulting from the evaluation of a broad spectrum of SPS (satellite power systems) concepts. As the various concepts matured, these requirements were updated to reflect the requirements identified for the projected satellite system/subsystem point design(s). The study established several candidate concepts which were presented to provide a basis for the selection of one or two approaches that would be given a more comprehensive examination. The two selected concepts were expanded and constitute the selected system point designs. The identified system/subsystem requirements was emphasized and information on the selected point design was provided. Author

**N79-16039\*** Rensselaer Polytechnic Inst., Troy, N. Y. Dept. of Electrical and Systems Engineering.

**SOLAR POWER SATELLITE RECTENNA DESIGN STUDY: DIRECTIONAL RECEIVING ELEMENTS AND PARALLEL-SERIES COMBINING ANALYSIS Final Report, 3 Feb. 1978**

Ronald J. Gutmann and Jose M. Borrego Dec. 1978 123 p refs

(Contract NAS9-15453)

(NASA-CR-151866) Avail: NTIS HC A06/MF A01 CSDL 22B

Rectenna conversion efficiencies (RF to dc) approximating 85 percent were demonstrated on a small scale, clearly indicating the feasibility and potential of efficiency of microwave power to dc. The overall cost estimates of the solar power satellite indicate that the baseline rectenna subsystem will be between 25 to 40 percent of the system cost. The directional receiving elements and element extensions were studied, along with power combining evaluation and evaluation extensions. J.A.M.

**N79-16067\*** Grumman Aerospace Corp., Bethpage, N.Y. **MANNED REMOTE WORK STATION DEVELOPMENT ARTICLE Interim Review No. 2**

8 Nov. 1978 260 p

(Grant NAS9-15507)

(NASA-CR-151871; NSS-MR-RP-011)

Avail: NTIS HC A12/MF A01 CSDL 22B

Flight article and associated design concepts are evaluated to meet fundamental requirements of a universal crew cabin to be used as a construction cherry picker, a space crane turret, a railed work station, or a free flyer. Key technology developments are embodied into a simulation program. A schedule and simulation test plan matrix is given for the open cabin cherry picker. A.R.H.

**N79-16135** West Virginia Univ., Morgantown. **THERMOELASTIC SOLUTIONS FOR IN-SITU GASIFICATION OF COAL Ph.D. Thesis**

Hsin-Fuh Wang 1978 250 p

Avail: Univ. Microfilms Order No. 7900893

Linear thermoelastic analyses of structural models associated with underground coal gasification (UCG) are conducted. Idealized crack and cavity configurations simulating the Longwall Generator concept and linked vertical wells concept of UCG are studied by deriving closed form solutions. The relevance of the proposed models and their general applications are provided. Four different isotropic, homogeneous thermoelastic models with steady-state heat conduction and prescribed constant temperature boundary conditions at the crack or cavity surface are investigated. The results provide fundamental data for the possible interpretation of cavity configurations, roof stability and related information. Research indicates that the thermomechanical responses are important in the consideration of UCG processes. Dissert. Abstr.

**N79-16136\*** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

**EFFECT OF BROADENED-SPECIFICATION FUELS ON AIRCRAFT ENGINES AND FUEL SYSTEMS**

R. A. Rudey 1979. 25 p refs To be presented at the 4th Intern. Symp. on Airbreathing Eng., Lake Buen Vista, Fla., 1-6 Apr. 1979; sponsored by AIAA

(NASA-TM-79086; E-9898) Avail: NTIS HC A02/MF A01 CSDL 21D

A wide variety of studies on the potential effects of broadened-specification fuels on future aircraft engines and fuel systems are summarized. The compositions and characteristics of aircraft fuels that may be derived from current and future crude-oil sources are described, and the most critical properties that may effect aircraft engines and fuel systems are identified and discussed. The problems that are most likely to be encountered because of changes in selected fuel properties are explored; and the related effects on engine performance, component durability and maintenance, and aircraft fuel-system performance are examined. The ability of current technology to accept possible future fuel specification changes is assessed and selected technological advances that can reduce the severity of the potential problems are illustrated. A.R.H.

**N79-16138\*** Princeton Univ., N. J. J. Guggenheim Labs. **FUNDAMENTAL COMBUSTION STUDIES OF EMULSIFIED FUELS FOR DIESEL APPLICATIONS Final Report, 1 Jul. 1974 - 30 Sep. 1977**

F. L. Dryer and I. Glassman, Dec. 1977. 233 p refs

(Grant NSF AER-76-08210)

(PB-287386/7; NSF/AER-76-08210)

Avail: NTIS HC A11/MF A01 CSDL 21B

The combustion characteristics of water-in-fuel emulsions were defined and the relationship of emulsion characteristics to the micro-explosion phenomena were examined. Research encompassed emulsion formation techniques, physical characteristics, emulsion coalescence kinetics (stability), single suspended free droplet combustion, spray characterization, and nucleate vaporization (of the internal phase) prediction. Results were used to critically evaluate published practical results, predict favorable applications for emulsion combustion, and guide full scale implementation research and development. GRA

**N79-16139\*** Versar, Inc., Springfield, Va. **ASSESSMENT OF COAL CLEANING TECHNOLOGY Annual Report, Jan. 1977 - Jan. 1978**

Lee C. McCandless and Robert B. Shaver Jul. 1978 164 p refs

(Contract EPA-68-02-2199)

(PB-287091/3; EPA-600/7-78-150; AR-1) Avail: NTIS HC A08/MF A01 CSDL 081

Topics of discussion include: (1) washability characteristics of coal, with emphasis on the correlations of various washability parameters; (2) current technology on coal comminution and gravity separation processes; (3) eleven major chemical coal cleaning processes; (4) current technology on mechanical and thermal drying and oil agglomeration; (5) slurry sampling techniques; and (6) coal preparation requirements for synthetic fuel conversion processes, in terms of particle size, moisture, ash, sulfur, and heating value. In addition, coal preparation requirements for 6 high-Btu gasification processes, 13 low-Btu

gasification processes, and 5 liquefaction processes are summarized. GRA

**N79-16140#** University of Southern California, Los Angeles. Inst. for Marine and Coastal Studies.

**COOKING WITH OFFSHORE OIL: A HANDBOOK FOR CALIFORNIA LOCAL GOVERNMENT**

Martin Chorich Aug. 1978 243 p refs Sponsored in part by US Civil Service Commission

(Grant NOAA-04-7-158-44113)

(PB-288656/2; USCSG-AS-01-78; NOAA-78100601) Avail: NTIS HC A11/MF A01 CSCL 10A

This handbook includes: (1) a brief introduction to the leasing process and outer continental shelf (OCS) development issues; (2) an OCS issues chart, summarizing and bringing together the material presented; (3) dissection of development issues and recommendations for planning recipes; (4) policy options open to local governments; (5) recommendations by policy makers involved in the OCS development process concerning promising courses of action, and (6) the appendices and bibliographic references. The appendices contain the correspondences local governments have used to respond to OCS development. GRA

**N79-16144#** National Technical Information Service, Springfield, Va.

**CRYOGENIC REFRIGERATION, VOLUME 2. A BIBLIOGRAPHY WITH ABSTRACTS Progress Report, 1973 - Oct. 1977**

William E. Reed Dec. 1978 236 p

(NTIS/PS-78/1261/3) Avail: NTIS HC \$28.00/MF \$28.00 CSCL 13A

Cryogenic cooling of electronic equipment, infrared equipment, infrared equipment, cryogenic storage vessels, magnetohydrodynamic generators, and superconducting magnets, coils, rotating machinery, and transmission lines is reported. Marine refrigeration of liquefied natural gas, cryogenic heat pipes, cryogenic heat transfer, and space applications are studied. Methods investigated include adiabatic demagnetization, electrocaloric effect, Joule-Thompson effect, thermoelectric cooling, and Crayton, Claude, Gifford-McMahon, Sterling, and Vuilleumier cycles. This updated bibliography contains 229 abstracts, none of which are new entries to the previous edition. GRA

**N79-16145#** National Technical Information Service, Springfield, Va.

**CRYOGENIC REFRIGERATION, VOLUME 3. A BIBLIOGRAPHY WITH ABSTRACTS Progress Report, Nov. 1977 - Nov. 1978**

William E. Reed Nov. 1978 84 p Supersedes NTIS/PS-77/1158; NTIS/PS-76/0871; NTIS/PS-75/826

(NTIS/PS-78/1262/1; NTIS/PS-77/1158; NTIS/PS-76/0871; NTIS/PS-75/826) Avail: NTIS HC \$28.00/MF \$28.00 CSCL 13A

Cryogenic cooling of electronic equipment, infrared equipment, cryogenic storage vessels, magnetohydrodynamic generators, and superconducting magnets, coils, rotating machinery, and transmission lines is reported. Marine refrigeration of liquefied natural gas, cryogenic heat pipes, cryogenic heat transfer, and space applications are studied. Methods investigated include adiabatic demagnetization, electrocaloric effect, Joule-Thompson effect, thermoelectric cooling, and Crayton, Claude, Gifford-McMahon, Sterling, and Vuilleumier cycles. This updated bibliography contains 77 abstracts, all of which are new entries to the previous edition. GRA

**N79-16148#** AIA Research Corp., Washington, D. C.

**PHASE ONE/BASE DATA FOR THE DEVELOPMENT OF ENERGY PERFORMANCE STANDARDS FOR NEW BUILDINGS: DATA ANALYSIS**

Jan. 1978 218 p ref Sponsored in part by DOE

(Contract HUD-H-2689)

(PB-286901/4; HUD-0000193)

Avail: NTIS

HC A10/MF A01 CSCL 13A

Features of the analysis method used to measure the designed energy performance of buildings are outlined. Major objectives of the analysis were to estimate the mean and 20th, 50th, and 80th percentiles for annual building energy performance figures in various climatic regions to estimate the energy performance of all buildings selected for inclusion in the sample; and to

estimate building energy performance by major component of energy and use. Criteria for the selection of an analysis method were devised, and a computerized technique was selected that calculates hourly zone solar and transmission loads for the year using input design loads. GRA

**N79-16150#** AIA Research Corp., Washington, D. C.

**PHASE ONE/BASE DATA FOR THE DEVELOPMENT OF ENERGY PERFORMANCE STANDARDS FOR NEW BUILDINGS: SAMPLE DESIGN**

30 Jan. 1978 107 p Prepared in cooperation with DOE, Washington, D.C.

(Contract HUD-H-2689)

(PB-286903/0; HUD-0000195)

Avail: NTIS

HC A06/MF A01 CSCL 13A

The sample design employed in a 1977 building energy performance survey for the Department of Housing and Urban Development is discussed. A sample of 37 standard metropolitan statistical areas (SMSA's) was selected from all SMSA's with a population over 250,000. The selection was simple random within strata defined by the population size of each SMSA, heating degree days of each SMSA, and cooling hours of each SMA. This sample of SMSA's was used to select a secondstage sample of buildings for 12 building types covered by the survey. The basic design requirement was to provide estimates of the 80th percentile of the distribution of energy per square foot per year in buildings for combinations of the 12 building types of 8 climatic zones. GRA

**N79-16210** Texas Univ. at Austin.

**ENERGY AND ECONOMIC ANALYSIS OF INDUSTRIAL PROCESS HEAT RECOVERY WITH HEAT PUMPS Ph.D. Thesis**

Alfredo Heli Urdanetta-Bohorquez 1978 280 p

Avail: Univ. Microfilms Order No. 7900645

A two-stream process scheme is considered as the basic heat pump heat recovery model around which the energy, economic analysis is developed. An algorithm is implemented to search for the heat pump cycle operational conditions that minimize energy consumption and maximize economic profitability. The measure of energy performance is the ratio of primary energy consumption by the heat pump system to primary energy consumption by the reference (no heat recovery) process configuration. The measure of economic profitability is an internal rate-of-return obtained from an incremental aftertax present worth analysis of the heat pump. Two economic scenarios are modeled to reflect future energy costs: a government regulated energy market and a free energy market option. Two investment strategies are modeled to analyze the incorporation of heat pumps within a process configuration: new design and retrofit. A food processing industry example and a petroleum refinery example are parametrically analyzed. Dissert. Abstr.

**N79-16260#** Von Karman Inst. for Fluid Dynamics, Rhode-Saint-Genese (Belgium).

**CLOSED CYCLE GAS TURBINES, VOLUME 1**

1977 381 p refs Proc. of Lectures held on 9-13 May, 1977 2 Vol.

(VKI-LS-100-Vol-1) Avail: NTIS HC A16/MF A01; Von Karman Inst. for Fluid Dyn. BF 4.500

High power and low power closed cycle turbines are studied. The following topics are discussed: (1) large closed cycle gas turbine plants; (2) the use of liquid natural gas as heat sink for power cycles; (3) the development of thermal prime movers for heat pump drive; and (4) dissociating gases of working fluids.

**N79-16261#** General Atomic Co., San Diego, Calif.

**LARGE CLOSED-CYCLE GAS TURBINE PLANT**

Colin F. McDonald In Von Karman Inst. for Fluid Dyn. Closed Cycle Gas Turbine, Vol. 1 1977 265 p refs

(Contract E(04-3)-167; Gen. Atomic Proj. 2095; Gen. Atomic Proj. 4351; Gen. Atomic Proj. 3227)

(GA-A-14311) Copyright. Avail: NTIS HC A16/MF A01; Von Karman Inst. for Fluid Dyn. BF 4.500

N79-16262

A plant with a high temperature gas cooled reactor (HTGR) as the heat source is designed. The design evolution for a large nuclear closed-cycle gas turbine power plant is summarized. A background on closed-cycle gas turbines, the incentives for the GT-HTGR, cycle selection, plant configuration studies, performance, selection of a reference plant design, component design activities, and a description of the waste heat binary power plant are presented. Development and testing alternatives, and related international programs in the closed-cycle gas turbine field are included. S.E.S.

**N79-16262#** Politecnico di Milano (Italy). Ist. di Macchine.  
**THE USE OF LIQUID NATURAL GAS AS HEAT SINK FOR POWER CYCLES**

G. Angelino / In Von Karman Inst. for Fluid Dyn. Closed Cycle Gas Turbines, Vol. 1 1977 40 p refs

Copyright. Avail: NTIS HC A16/MF A01; Von Karman Inst. for Fluid Dyn. BF 4.500

The thermodynamics of power cycles employing LNG as heat sink is discussed. Condensation cycles in simple or in elaborate versions, employing non-toxic, non-flammable, inert organic working fluids (CF<sub>4</sub>, C<sub>2</sub>F<sub>6</sub>, CHF<sub>3</sub>, C<sub>3</sub>F<sub>8</sub>), yield the best overall performance for LNG vaporization at subcritical pressure. For supercritical vaporization, heat rejection from Brayton cycles naturally fits heat sink thermal characteristics, which results in a particularly high efficiency for closed gas cycles. If only a fraction of the cooling capability of LNG is devoted to power uses, condensation cycles are superior to gas cycles even at supercritical LNG pressures. Under the most favourable circumstances gas cycles achieve efficiencies of around 60 percent, while some elaborate condensation cycles attain the 70 percent level. Author

**N79-16263#** Politecnico di Milano (Italy). Ist. di Macchine.  
**DEVELOPMENT OF THERMAL PRIME MOVERS FOR HEAT PUMP DRIVE**

G. Angelino / In Von Karman Inst. for Fluid Dyn. Closed Cycle Gas Turbines, Vol. 1 1977 25 p refs

Copyright. Avail: NTIS HC A16/MF A01; Von Karman Inst. for Fluid Dyn. BF 4.500

The energy savings connected with low grade heat generation by means of heat pumps powered by thermal engines whose waste heat is recovered are illustrated. The performance of the system is compared with that of alternate methods of low temperature heat production. The characteristics of thermal prime movers adequate for the proposed application which are either available or under development are reviewed. Particular attention is devoted to organic working fluid cycles whose basic thermodynamics and main technical features are discussed. Results are reported of an example of technical and economical analysis relating to the heating of a large building by means of a thermal engine-heat pump system. Author

**N79-16268#** Politecnico di Milano (Italy). Ist. di Macchine.  
**POWER CYCLES AND WORKING FLUIDS FOR LOW TEMPERATURE HEAT SOURCES**

E. Macchi / In Von Karman Inst. for Fluid Dyn. Closed Cycle Gas Turbines, Vol 2 1977 44 p refs

Copyright. Avail: NTIS HC A12/MF A01; Von Karman Inst. for Fluid Dyn. BF 4.500

By making use of proper working fluids and cycles, mechanical power can be economically obtained by relatively low-temperature heat sources. Some possible applications for these engines are reviewed. Choice criteria of working fluids and thermodynamic cycles for various heat sources temperatures and power outputs are discussed. Advantages of organic fluids versus steam are evidenced, both from thermodynamic and expander design points of view. The possibility of obtaining efficient turbines even at very low power levels by making use of low condensation pressure is discussed. Experimental results of a recently developed 3 kW prototype engine for solar power application, operating between 75 and 30 C are presented. G.Y.

**N79-16342#** Federal-State Land Use Planning Commission for Alaska, Anchorage.

**NORTHERN ALASKA HYDROCARBON RESOURCES**

Jerry D. Kreitner May 1978 79 p refs  
(PB-287394/1; FSLUPCA-34) Avail: NTIS HC A05/MF A01 CSCL 10A

The private, federal, and state oil and gas initiatives in Northern Alaska over the past 35 years are brought together. It treats Northern Alaska oil and gas provinces as a planning unit, rather than using the classic (private, state, etc.) divisions. GRA

**N79-16345** City Univ. of New York.

**MODELLING AND CONTROL OF A FLUIDIZED BED GASIFIER Ph.D. Thesis**

Moshe Kutten 1978 182 p  
Avail: Univ. Microfilms Order No. 7900791

An evaluation of the steady state and the dynamic behavior of an air blown fluidized bed coal gasifier to producing low BTU gas is presented. A simplified model of such a gasifier is presented. It is shown that the steady state range of control can be sometimes considerably smaller than indicated by purely hydrodynamic consideration, as lower flow rates can lead to higher conversions. The dynamic behavior shows a short time response dominated by the thermal inertia of the coal bed and a long time response, which is a function of the adjustment of the bed ash content to different flow rates. Both the dynamic and steady state features of the system strongly depend on the design of the system. The results of the thesis illustrates the type of problems that may be encountered and suggests some potential solutions. Dissert. Abstr.

**N79-16346** California Univ., Los Angeles.

**AEROELASTIC RESPONSE AND STABILITY OF A COUPLED ROTOR/SUPPORT SYSTEM WITH APPLICATION TO LARGE HORIZONTAL AXIS WITH TURBINES Ph.D. Thesis**

William Warmbrodt 1978 326 p refs  
Avail: Univ. Microfilms Order No. 7901415

The derivation of a governing set of nonlinear equations of motion for a coupled rotor/support system is presented. The model includes an n-bladed rotor with elastic blade flap and lead-lag degrees of freedom. The blades can have precone, pitch bearing offset, built-in twist, and cross sectional offsets between the aerodynamic center, the center of mass, and the elastic axis. The rotor support has two translational degrees of freedom and three rotational degrees of freedom. The general set of equations were specialized to analytically represent a coupled n-bladed rotor/fuselage model of a helicopter in hover or forward flight. The fuselage was modeled as a rigid body. Inertia, aerodynamic, structural, and gravitational loads are considered. Wind gusts in all three directions was included. Rotor/fuselage matching was performed by requiring force and moment equilibrium between the rotor and the fuselage. Dissert. Abstr.

**N79-16349** Nebraska Univ. - Lincoln.

**PARAMETER ESTIMATION AND VALIDATION OF A SOLAR ASSISTED HEAT PUMP MODEL Ph.D. Thesis**

Bing Chen 1978 235 p  
Avail: Univ. Microfilms Order No. 7900300

A methodology is described which employs parameter estimation techniques for a model that accurately simulates the performance of an existing solar assisted heat pump structure. The model will then serve as the basis for the future application of various techniques to determine optimal control strategies, to minimize component sizing and to evaluate the performance (by simulation) of alternate solar energy systems. The model described in this thesis incorporates onsite weather data, mechanical system characteristics, heat flow dynamics, and control logic. A set of difference equations is developed. A weighted least squares algorithm is employed to estimate the model's parameters. The model is used with a known weather profile to predict heat pump performance for comparison with actual performance data. Dissert. Abstr.

**N79-16351\*** Gnostic Concepts, Inc., Menlo Park, Calif.  
**INDUSTRIALIZATION STUDY, PHASE 2 Final Report**  
 5 Jan. 1979 129 p refs Prepared for JPL and DOE  
 (Contracts NAS7-100; JPL-954899)  
 (NASA-CR-158015) Avail: NTIS HC A07/MF A01 CSCL 10A

The potentials and requirements of advanced photovoltaic technologies still in their early developmental stages were evaluated and compared to the present day single crystal silicon wafer technology and to each other. The major areas of consideration include polycrystalline and amorphous silicon, single crystal and polycrystalline gallium arsenide, and single crystal and polycrystalline cadmium sulfide. A rank ordering of the advanced technologies is provided. The various ranking schemes were based upon present-day efficiency levels, their stability and long-term reliability prospects, material availability, capital investments both at the laboratory and production level, and associated variable costs. An estimate of the timing of the possible readiness of these advanced technologies for technology development programs and industrialization is presented along with a set of recommended government actions concerning the various advanced technologies. A.R.H.

**N79-16352\*** Committee on Interstate and Foreign Commerce (U. S. House).

**ENERGY AND THE ECONOMY: THE ECONOMIC IMPACT OF ALTERNATIVE ENERGY SUPPLY-DEMAND ASSUMPTIONS**

Washington GPO 1978 34 p refs Study for Subcomm. on Energy and Power of the Comm. on Interstate and Foreign Commerce, Apr. 1978 Prepared by Library of Congr., Congressional Res. Service  
 (H-Print-95-51; GPO-22-673) Avail: Subcomm. on Energy and Power

Several energy scenarios were developed and an attempt to measure the impact of these on the U.S. economy is made. The energy scenarios are studied as cases and include: base case; conservation case; high electric case; high oil case; and some caveats. The economic impacts studied are: employment and unemployment; inflation; investment; personal consumption; and foreign trade. Figures and data tables are presented. G.Y.

**N79-16353\*** Committee on Interstate and Foreign Commerce (U. S. House).

**INDUSTRIAL ENERGY CONSERVATION**

Washington GPO 1978 171 p refs Hearings on H.R. 8985 before the Subcomm. on Energy and Power of the Comm. on Interstate and Foreign Commerce, 95th Congr., 1st Sess., 27 and 29 Sep. 1977

(GPO-24-067) Avail: Subcomm. on Energy and Power

A Bill, H.R. 8985, is introduced which requires the Department of Energy to establish test procedures, labeling rules, and energy efficiency standards for electric motors and pumps, and for other purposes. Representatives from Government and industry give testimony on the proposed Bill. G.Y.

**N79-16355\*** National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

**POWER TRAIN ANALYSIS FOR THE DOE/NASA 100-kW WIND TURBINE GENERATOR Final Report**

Robert C. Seidel, Harold Gold, and Leon M. Wenzel Oct. 1978 57 p refs Prepared for DOE  
 (Contract E(49-26)-1028)

(NASA-TM-78997; DOE/NASA/1028-78/19; E-9413) Avail: NTIS HC A04/MF A01 CSCL 10A

Progress in explaining variations of power experienced in the on-line operation of a 100 kW experimental wind turbine-generator is reported. Data are presented that show the oscillations tend to be characteristic of a wind-driven synchronous generator because of low torsional damping in the power train, resonances of its large structure, and excitation by unsteady and nonuniform wind flow. The report includes dynamic analysis of the drive-train torsion, the generator, passive driveline damping, and active pitch control as well as correlation with

experimental recordings. The analysis assumes one machine on an infinite bus with constant generator-field excitation. Author.

**N79-16357\*** National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

**AN OPERATING 200-kW HORIZONTAL AXIS WIND TURBINE**

Charles L. Hunnicutt (Lockheed Aircraft Service Co., Ontario, Calif.), Bradford Linscott, and Robert A. Wolf 1978 25 p Presented at 23rd Natl. SAMPE Symp. and Exhibition, Anaheim, Calif., 2-4 May 1978

(Contract E(49-26)-1004)

(NASA-TM-79034; E-9833) Avail: NTIS HC A02/MF A01 CSCL 10B

The Mod-OA wind turbine blades were rotated for the first time on November 30, 1977, establishing the Mod-OA as the first wind-driven generator in 35 years to be continually tied into an electrical power system which services a community. Tower-mounted equipment and blade structural design and fabrication are discussed. J.M.S.

**N79-16359\*** IBM Federal Systems Div., Huntsville, Ala.  
**SYSTEM DESIGN PACKAGE FOR SIMS PROTOTYPE SYSTEM 3, SOLAR HEATING AND DOMESTIC HOT WATER**

Nov. 1978 80 p Prepared for DOE

(Contract NAS8-32036)

(NASA-CR-150840) Avail: NTIS HC A05/MF A01 CSCL 10B

A collation of documents and drawings are presented that describe a prototype solar heating and hot water system using liquid flat plate collectors and a gas or electric furnace energy subsystem. The system was designed for installation into a single-family dwelling. The description, performance specification, subsystem drawings, verification plan/procedure, and hazard analysis of the system are packaged for evaluation of the system with information sufficient to assemble a similar system. G.Y.

**N79-16360\*** Owens-Illinois, Inc., Toledo, Ohio. Solar Energy Products Group.

**QUALIFICATION TEST AND ANALYSIS REPORT: SOLAR COLLECTORS**

Dec. 1978 147 p Prepared for DOE

(Contract NAS8-32259)

(NASA-CR-150860) Avail: NTIS HC A07/MF A01 CSCL 10B

Test results show that the Owens-Illinois Sunpak TM Model SEC 601 air-cooled collector meets the national standards and codes as defined in the Subsystem Performance Specification and Verification Plan of NASA/MSFC, dated October 28, 1976. The program calls for the development, fabrication, qualification and delivery of an air-cooled solar collector for solar heating, combined heating and cooling, and/or hot water systems. G.Y.

**N79-16361\*** IBM Federal Systems Div., Huntsville, Ala.  
**SYSTEM DESIGN PACKAGE FOR SIMS PROTOTYPE SYSTEM 4, SOLAR HEATING AND DOMESTIC HOT WATER**

Nov. 1978 145 p refs Prepared for DOE

(Contract NAS8-32036)

(NASA-CR-150839) Avail: NTIS HC A07/MF A01 CSCL 10B

The system consisted of a modular designed prepackaged solar unit, containing solar collectors, a rock storage container, blowers, dampers, ducting, air-to-water heat exchanger, DHW preheat tank, piping, and system controls. The system was designed to be installed adjacent to a small single family dwelling. The description, performance specification, subsystem drawings, verification plan/procedure, and hazard analysis of the system were packaged for evaluation. J.A.M.

**N79-16365\*** Varian Associates, Lexington, Mass. Lexington Vacuum Div.

**SLICING OF SILICON INTO SHEET MATERIAL: SILICON SHEET GROWTH DEVELOPMENT FOR THE LARGE AREA**

N79-16366

**SILICON SHEET TASK OF THE LOW COST SILICON SOLAR ARRAY PROJECT Quarterly Report, 19 Jun. 1978 - 27 Oct. 1978**

J. R. Fleming 20 Nov. 1978 40 p Sponsored in part by DOE

(Contracts NAS7-100; JPL-954374)

(NASA-CR-158082; JPL-954374-78/1; QR-10) Avail: NTIS HC A03/MF A01 CSCL 10A

The limits of blade tolerance were defined. The standard blades are T-2 thickness tolerance. Good results were obtained by using a slurry fluid consisting of mineral oil and a lubricity additive. Adjustments of the formulation and fine tuning of the cutting process with the new fluid are necessary. Test results and consultation indicate that the blade breakage encountered with water based slurries is unavoidable. Two full capacity (974 wafer) runs were made on the large prototype saw. Both runs resulted in extremely low yield. However, the reasons for the low yield were lack of proper technique rather than problems with machine function. The test on the effect of amount of material etched off of an as-sawn wafer on solar cell efficiency were completed. The results agree with previous work at JPL in that the minimum material removed per side that gives maximum efficiency is on the order of 10 microns. G.Y.

**N79-16366\*# Hughes Research Labs., Malibu, Calif. GaAs SOLAR CELL DEVELOPMENT Quarterly Report, 25 Oct. 1978 - 25 Jan. 1979**

Jan. 1979 18 p Sponsored by NASA Prepared for JPL

(Contract JPL-955062)

(NASA-CR-158090; QR-3) Avail: NTIS HC A02/MF A01 CSCL 10A

The four (AlGa)As-GaAs solar cells were fabricated and will be delivered for radiation damage testing using 1 MeV electrons. These cells were LPE grown at 700 C for 4 minutes. The junction depth was measured to be 0.3 micron using a secondary electron microscope. The radiation model for the shallow junction cells was verified. Some mesa diodes were also fabricated and will be irradiated along with the cells for parallel evaluations of their electrical characteristics. J.A.M.

**N79-16368\*# Solarex Corp., Rockville, Md. EVALUATION OF THE TECHNICAL FEASIBILITY AND EFFECTIVE COST OF VARIOUS WAFER THICKNESSES FOR THE MANUFACTURE OF SOLAR CELLS Quarterly Progress Report, 15 Jul. 1978 - 30 Sep. 1978**

1978 26 p Sponsored in part by DOE

(Contract JPL-955077; NAS7-100)

(NASA-CR-158095; QPR-1; JPL-955077-78/3) Avail: NTIS HC A03/MF A01 CSCL 10A

Three wafering demonstration runs were completed on the Yasunaga wire saw. Wafer thickness/taper uniformity is excellent. Many small problems were encountered with Yasunaga accessories, slowing the effort. A wafer characterization cycle was defined and will be initiated during the next period. Author

**N79-16369\*# Kayex Corp., Rochester, N. Y. CONTINUOUS CZOCHRALSKI GROWTH: SILICON SHEET GROWTH DEVELOPMENT OF THE LARGE AREA SILICON SHEET TASK OF THE LOW COST SILICON SOLAR ARRAY PROJECT Annual Progress Report, 1 Oct. 1977 - 30 Sep. 1978**

1978 54 p Sponsored by DOE and JPL

(NASA-CR-158096; JPL-954888-78/4; APR-1) Avail: NTIS HC A04/MF A01 CSCL 10A

The primary objective of this contract is to develop equipment and methods for the economic production of single crystal ingot material by the continuous Czochralski (CZ) process. Continuous CZ is defined for the purpose of this work as the growth of at least 100 kilograms of ingot from only one melt container. During the reporting period (October, 1977 - September, 1978), a modified grower was made fully functional and several recharge runs were performed. The largest run lasted 44 hours and over 42 kg of ingot was produced. Little, if any, degradation in efficiency was observed as a result of pulling multiple crystals from one crucible. Solar efficiencies observed were between 9.3 and 10.4% AMO (13.0 and 14.6% AMI) compared to 10.5% (14.7% AMI) for optimum CZ material control samples. Using the SAMICS/IPEG

format, economic analysis of continuous CZ suggests that 1986 DoE cost goals can only be met by the growth of large diameter, large mass crystals. Author

**N79-16370\*# Owens-Illinois, Inc., Toledo, Ohio. ANALYSIS AND EXPERIMENTAL TESTS OF A HIGH-PERFORMANCE EVACUATED TUBULAR COLLECTOR**

D. C. Beekley and G. R. Mather, Jr. Dec. 1978 56 p refs Prepared for DOE

(Contract NAS8-32259)

(NASA-CR-150874) Avail: NTIS HC A04/MF A01 CSCL 10B

A high-performance collector based on the use of all-glass, evacuated tubular collector elements is described and analyzed, and supporting experimental data presented. The collector operated with excellent efficiency at temperatures high enough to drive existing air conditioning units, and showed good performance under diffuse light and low insolation conditions. Collector efficiency was insensitive to operating temperature, ambient temperature, and wind speed. In addition, air, as well as liquid, can be used as the heat transfer fluid, with no significant performance penalty. While the equations governing the useful energy produced can be cast in a form similar to that for flat plate collectors, several important parameters were unique in a number of respects. The loss coefficient was unusually low, while the flow factor and effective insolation were unusually high. Author

**N79-16372\*# Solaron Corp., Denver, Colo. PROTOTYPE SOLAR HEATING AND COOLING SYSTEMS INCLUDING POTABLE HOT WATER Quarterly Reports, Nov. 1978 - Jun. 1977**

Dec. 1978 89 p Prepared for DOE

(Contract NAS8-32249)

(NASA-CR-150861) Avail: NTIS HC A05/MF A01 CSCL 10B

Progress is reviewed in the development, delivery, and support of two prototype solar heating and cooling systems including potable hot water. The system consisted of the following subsystems: collector, auxiliary heating, potable hot water, storage, control, transport, and government-furnished site data acquisition. J.A.M.

**N79-16373\*# Solar Engineering and Equipment Co., Metairie, La. INSTALLATION PACKAGE FOR HYDE MEMORIAL OBSERVATORY, LINCOLN, NEBRASKA**

Dec. 1978 36 p Prepared for DOE

(Contract NAS8-32247)

(NASA-CR-150867) Avail: NTIS HC A03/MF A01 CSCL 10B

Installation information for a solar heating system installed in Hyde Memorial Observatory at Lincoln, Nebraska is presented. This package included a system operation and maintenance manual, hardware brochures, schematics, system operating modes, and drawings. This prototype solar heating system consisted of the following subsystems: solar collector, control, and storage. J.A.M.

**N79-16374\*# Energy Research Corp., Bethel, Conn. FABRICATION AND TESTING OF SILVER-HYDROGEN CELLS**

M. G. Klein Nov. 1978 48 p

(Contract NAS3-19780)

(NASA-CR-159431) Avail: NTIS HC A03/MF A01 CSCL 10B

The development and life testing of single electrode and multi electrode stacks to optimize the individual components and characterize the performance of a silver hydrogen battery system are described. A NASA-developed inorganic separator material was used as the main separator within the cells. Single electrode test cells were cycled at 75% of nominal capacity out through approximately 1,000 cycles in a number of cases where deterioration in performance was observed. This deterioration appears to be a decay in usable capacity of the silver electrode; but the exact mechanism is still unidentified. Twenty ampere-hour boilerplate test cells consisting of a stack of ten silver

electrodes and twenty hydrogen electrodes were cycled also at 75% depth of discharge. The oldest stack achieved 522 stable cycles to the end of the program. Weight analysis of light-weight cells showed that 50 ampere-hour cells with improved components could be capable of as much as 40 watt hours per pound.

A.R.H.

**N79-16377\*** Burns and McDonnell, Kansas City, Mo.  
**ASSESSMENT OF THE POTENTIAL OF SOLAR THERMAL SMALL POWER SYSTEMS IN SMALL UTILITIES**  
**Final Report**

P. Steitz, L. G. Mayo, and S. P. Perkins, Jr. Nov. 1978 222 p refs Prepared for JPL and DOE  
 (Contract JPL-954971)  
 (NASA-CR-158093; JPL-1060-14; Doc-78-008-4-000) Avail: NTIS HC A10/MF A01 CSCL 10B

The potential economic benefit of small solar thermal electric power systems to small municipal and rural electric utilities is assessed. Five different solar thermal small power system configurations were considered in three different solar thermal technologies. The configurations included: (1) 1 MW, 2 MW, and 10 MW parabolic dish concentrators with a 15 kW heat engine mounted at the focal point of each dish, these systems utilized advanced battery energy storage; (2) a 10 MW system with variable slot concentrators and central steam Rankine energy conversion, this system utilized sensible thermal energy storage; and (3) a 50 MW central receiver system consisting of a field of heliostats concentrating energy on a tower-mounted receiver and a central steam Rankine conversion system, this system also utilized sensible thermal storage. The results are summarized in terms of break-even capital costs. The break-even capital cost was defined as the solar thermal plant capital cost which would have to be achieved in order for the solar thermal plants to penetrate 10 percent of the reference small utility generation mix by the year 2000. The calculated break-even capital costs are presented.

F.O.S.

**N79-16378\*** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.  
**ANALYSIS AND EVALUATION OF PROCESS AND EQUIPMENT IN TASKS 2 AND 4 OF THE LOW COST SOLAR ARRAY PROJECT**  
**Quarterly Report, Oct. 1977 - Jan. 1978**

H. Goldman and M. Wolf Aug. 1978 118 p refs Sponsored by NASA and DOE  
 (Contract JPL-954796)  
 (NASA-CR-158089; DOE/JPL-954796-77/1) Avail: NTIS HC A06/MF A01 CSCL 10A

Several experimental and projected Czochralski crystal growing process methods were studied and compared to available operations and cost-data of recent production Cz-pulling, in order to elucidate the role of the dominant cost contributing factors. From this analysis, it becomes apparent that substantial cost reductions can be realized from technical advancements which fall into four categories: an increase in furnace productivity; the reduction of crucible cost through use of the crucible for the equivalent of multiple state-of-the-art crystals; the combined effect of several smaller technical improvements; and a carry over effect of the expected availability of semiconductor grade polysilicon at greatly reduced prices. A format for techno-economic analysis of solar cell production processes was developed, called the University of Pennsylvania Process Characterization (UPPC) format. The accumulated Cz process data are presented.

Author

**N79-16379\*** British Aerospace Dynamics Group, Bristol (England). Electronic and Space Systems.  
**STUDY ON SOLAR ARRAYS FOR PROGRAMMES LEADING FROM THE EXTENSION OF SPACELAB TOWARDS SPACE PLATFORMS**  
**Final Report**

P. R. C. Gillett Paris ESA Jun. 1978 98 p  
 (Contract ESA-3404/77-F-HEW(SC))  
 (ESS/SS-878; ESA-CR(P)-1112) Avail: NTIS HC A05/MF A01

A description of the major requirements of a set of candidate missions is presented and some preliminary solar array designs are given. A development strategy is outlined and the principal areas of new technology identified.

J.M.S.

**N79-16380\*** Utah State Univ., Logan. Dept. of Sociology, Social Work, and Anthropology.

**LOCAL PERCEPTIONS OF ENERGY DEVELOPMENT: THE CASE OF THE KAIPAROWITS PLATEAU**

Stephan B. LoveJay, Jeni M. Varady, ed., and Orson L. Anderson, ed. Nov. 1977 79 p refs Sponsored by NSF  
 (PB-287314/9; Bull-62; NSF/RA-770592) Avail: NTIS HC A05/MF A01 CSCL 10A

Proposed energy developments in the predominantly rural Four Corners area of the Southwest are threatening the residents' lifestyles. Data from a simple random sample of household heads in several rural communities in southern Utah and northern Arizona lend support to the proposition that the local citizens are eager to have large-scale energy projects in the Four Corners region. The citizens are willing to exchange elements of their current lifestyles for what are perceived as economic and employment benefits. The analysis presented here suggests that they tend to overemphasize the expected benefits while de-emphasizing, or remaining ignorant of potential disadvantages resulting from such developments. Some explanations for this behavior are examined.

GRA

**N79-16382\*** Hawaii Univ., Honolulu. Dept. of Meteorology.  
**OAHU WIND POWER SURVEY**

Colin S. Ramage, P. Anders Daniels, Thomas A. Schroeder, and Noel J. Thompson May 1977 44 p refs Sponsored in part by Hawaii Natural Energy Inst., Honolulu  
 (Grant NSF AER-76-05596)  
 (PB-287361/0; UHMET-77-01) Avail: NTIS HC A03/MF A01 CSCL 04A

At seventeen potentially windy sites, calibrated anemometers and wind vanes were installed and recordings made on computer-processable magnetic tape cassettes. From monthly mean wind speeds--normalized by comparing with Honolulu Airport mean winds--it was concluded that about 23 mi/hr represented the highest average annual wind speed likely to be attained on Oahu and that the Koko Head and Kahuku areas gave the most promise for wind energy generation. Diurnal variation of the wind in these areas roughly parallels diurnal variation of electric power demand.

GRA

**N79-16384\*** National Bureau of Standards, Washington, D.C.  
**Center for Building Technology.**

**THE EFFECTS OF RESOURCE IMPACT FACTORS ON ENERGY CONSERVATION STANDARDS FOR BUILDINGS**  
**Final Report**

Sep. 1978 61 p refs Sponsored by DOE  
 (PB-286909/7; NBS-BSS-114; LC-78-606072) Avail: NTIS HC A04/MF A01 CSCL 10A

The proper price for energy to be used in the development of optimum (i.e., cost-effective) energy conservation performance standards for buildings is considered. It is shown that the appropriate price for energy is its social value, which can be determined through the development and application of resource impact factors (RIF's). Some guidelines are provided for the formulation and development of RIF's. A life-cycle cost minimization model for determining the optimum conservation standard is employed to show how the use of RIF's would generally lower the maximum allowable energy consumption specified in the standard. Finally, geometric and algebraic measures are derived for the net gain in economic efficiency that would result from using RIF's in developing energy conservation performance standards.

GRA

**N79-16385\*** Office of the County Clerk, El Centro, Calif.  
**GEOTHERMAL ELEMENT, IMPERIAL COUNTY, CALIFORNIA**

S. Edmunds, J. Sullivan, and M. Goldsmith 1977 156 p  
 (Grant NSF AER-75-08793)  
 (PB-287115/0; NSF/RA-770652) Avail: NTIS HC A08/MF A01 CSCL 10A

Research methodology a brief history of geothermal development in the county, and a general history and physical characteristics of the county are described. A framework of the county master plan for geothermal development, its implications, and short and long range planning procedures was also considered.

GRA

**N79-16388** Rutgers - The State Univ., New Brunswick, N. J.  
**STIMULATED BIODEGRADATION OF WASTE PETROLEUM**  
**Ph.D. Thesis**

John Thomas Dibble 1978 160 p

Avail: Univ. Microfilms Order No. 7901249

Petroleum spilled on land or water not contained and collected will eventually be subject to biodegradation. The disposal of refinery oil sludge by biodegradation in the soil is presently a partially defined process. This thesis is concerned with the development of methods to stimulate the rate and extent of petroleum biodegradation. The biodegradation of South Louisiana (SL) crude oil, and the effects of nitrogen, phosphorus and iron supplements on this process were compared in a polluted and in a relatively clean littoral seawater sample taken along the New Jersey coast. The optimal soil management practices for the disposal of waste oil sludges on land were determined in laboratory and field experiments. Various fertilizer formulations were tested in lysimeter columns for their effect on oil sludge biodegradation and leachate quality. An accidental pipeline break provided an opportunity to observe the effect of some of the developed management techniques in the large-scale rehabilitation of agricultural land.

Dissert. Abstr.

**N79-16389** Houston Univ., Tex.  
**ENVIRONMENTAL EFFECTS OF OFFSHORE OIL PRODUCTION**  
**Ph.D. Thesis**

Brenda Pitts Basile 1978 289 p

Avail: Univ. Microfilms Order No. 7901184

Analytical methodology for the quantitation of alkanes, aromatic hydrocarbons, and sulfur was developed and was applied to the study of the environmental effects of offshore oil production. Completely deuteriated alkanes are separated from the corresponding unlabelled alkanes and serve as internal standards for the quantitation of environmental alkanes by gas chromatography alone. This technique provided a detection limit of 50 ng/l for hydrocarbons in seawater and 100 ng/g for hydrocarbons in sediments and in biological samples. The major conclusions from this study are: (1) There is petroleum contamination of water in this area of the Gulf of Mexico, but beyond 0.2 km of the production platform, this contamination cannot be ascribed to Buccaneer oilfield production activities. (2) Biota and sediments outside of the immediate vicinity of the production platforms do not contain petroleum hydrocarbons. This is especially important since this could affect the commercial fishing industry in the area.

Dissert. Abstr.

**N79-16437#** California Univ., Santa Barbara. Marine Science Inst.

**OIL POLLUTION REPORTS, VOLUME 5, NUMBER 2**  
**Quarterly Report, Feb. - May 1978**

Helmut Ehrenspeck, Elizabeth Sorenson, Jim Cook, and Barbara Searles Aug. 1978 256 p refs

(Grant EPA-R-805052)

(PB-287071/5; EPA-600/7-78-160-Vol-5) Avail: NTIS  
 HC A12/MF A01 CSCL 13B

A quarterly compilation of abstracts of current oil pollution-related literature, research projects, and conferences is presented. Comprehensive coverage of terrestrial and aquatic oil pollution and its prevention and control is provided, with emphasis on the marine environment. Citations and summaries of 1975 to 1978 scientific and technical publications, and patents; status and summaries of current research programs; and information on current meetings are given.

GRA

**N79-16439#** Research Triangle Inst., Research Triangle Park, N. C.

**COMPILATION OF LEVEL 1 ENVIRONMENTAL ASSESSMENT DATA Final Report, Sep. 1977 - Jun. 1978**

N. H. Gaskins and F. W. Sexton Oct. 1978 504 p refs

(Contract EPA-68-02-2156)

(PB-286924/6; EPA-600/2-78-211) Avail: NTIS  
 HC A22/MF A01 CSCL 13B

The data are organized within each study by the analytical technique used to generate them. Each study is summarized,

followed by the data generated in that study. The studies are organized by industrial type: chemically active fluidized bed combustor, coal-fired boiler, coal-fired power plant, new energy source, coke production, electric arc furnace, fluidized bed combustor, home heater multi-source source, ocean incinerator, oil burner, and textile. The report documents sampling and analytical techniques that were used which are not specified in Level 1. It also includes trends and anomalies that were detected in the 19 studies.

GRA

**N79-16448#** Catalytic, Inc., Charlotte, N. C.  
**ENVIRONMENTAL ASSESSMENT FOR RESIDUAL OIL UTILIZATION Annual Report, May 1977 - May 1978**

M. F. Tyndall, F. D. Kodras, J. K. Puckett, R. A. Symonds, and W. C. Yu Sep. 1978 183 p refs

(Contract EPA-68-02-2155)

(PB-286982/4; EPA-600/7-78-175; AR-2) Avail: NTIS  
 HC A09/MF A01 CSCL 13B

Progress in an environmental assessment of processes using residual oil for electric power generation is reported. Emissions data from the literature and preliminary sampling are presented with material balances and flow diagrams for hydrodesulfurization, flue gas desulfurization, partial oxidation, and chemically active fluid bed processes. A computer program for a theoretical engineering analysis that will provide emissions output for the processes studied is described. Multimedia Environmental Goals (MEGs) and Minimum Acute Toxicity Effluents (MATES) are used to develop pollutant prioritization and source analysis models. Methods for developing economic cost models are described.

GRA

**N79-16497#** AIA Research Corp., Washington, D. C.  
**PHASE ONE/BASE DATA FOR THE DEVELOPMENT OF ENERGY PERFORMANCE STANDARDS FOR NEW BUILDINGS. CLIMATIC CLASSIFICATION**

30 Jan. 1978 39 p

(Contract HUD-H-2689)

(PB-286900/6; HUD-0000190)

Avail: NTIS

HC A04/MF A01 CSCL 04B

Alternatives for the development of an adequate climatic classification system for use in establishing energy performance standards for new buildings were examined. Criteria were devised to ensure reasonable applicability of the selected climatic classification system, and a preliminary examination of climatic variables and their relationship to energy consumption was conducted. The development of a graphic matrix to illustrate relationships between estimated energy performance and both building type and climatic region is described and illustrated.

GRA

**N79-16668** Florida Univ., Gainesville.  
**MHD GENERATOR DUCT FLOW WITH CROSS STREAM DEPENDENT FLOW PROPERTIES Ph.D. Thesis**

Thomas Albert Trovillion 1978 207 p

Avail: Univ. Microfilms Order No. 7900099

The problem of steady laminar flow of an incompressible viscous conducting fluid in a rectangular duct is considered with finite aspect ratio of the cross section. An external magnetic field is applied transverse to the flow in a Faraday generator configuration. The governing equations for the modeling of the working fluid are derived from the usual magnetohydrodynamic assumptions yielding two simultaneous equations in terms of the velocity and induced magnetic field. A finite difference approach is taken to the solution of these equations using a modification of the Peaceman Rachford alternating direction implicit relaxation scheme. The finite difference solution is employed to obtain plots of the current streamlines and velocity contours, the volume flow rate through the channel, and the efficiency of the generator. These results are then examined to determine the effect on the flow characteristics produced by changes in load resistance, electrode conductivity, aspect ratio, and the assumed profile of conductivity and viscosity variation.

Dissert. Abstr

**N79-16704** Oklahoma Univ., Norman.  
**THERMAL AND KINETIC ANALYSIS OF THE PYROLYSIS OF COALS Ph.D. Thesis**

Vidyutkumar Vamanray Hathi 1978 275 p

Avail: Univ. Microfilms Order No. 7824598



The thermal decomposition (pyrolysis) of nine bituminous coals of the United States was investigated in a nitrogen atmosphere. Weight loss and rate of weight loss were measured at heating rates of 160, 80, 40, 20 and 10 C/min. The qualitative behavior of these data confirmed observations reported by others on similar coals in that the major devolatilization occurred between 300-700 C with the peaks shifting to higher temperatures at faster heating rates. Kinetic parameters for each heating rate were derived from these measurements by means of a model which was used successfully to describe the pyrolysis of woods and wildland fuels. The decomposition of bituminous coals is endothermic up to 500 C and exothermic thereafter; the energy of pyrolysis is more exothermic with decreasing heating rates.

Dissert. Abstr.

**N79-16721\*** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

**INITIAL COMPARISON OF SINGLE CYLINDER STIRLING ENGINE COMPUTER MODEL PREDICTIONS WITH TEST RESULTS**

Roy C. Tew, Jr., Lanny G. Thieme, and David Miao 1979 37 p refs Presented at the Intern. Congr. and Exposition, Detroit, 26 Feb. 1979 - 4 Mar. 1979; sponsored by the Soc. of Automotive Engr.

(Contract EC-77-A-31-1040)

(NASA-TM-79044; DOE/NASA/1040-78/30; E-9848) Avail: NTIS HC A03/MF A01 CSCL 10B

A Stirling engine digital computer model developed at NASA Lewis Research Center was configured to predict the performance of the GPU-3 single-cylinder rhombic drive engine. Revisions to the basic equations and assumptions are discussed. Model predictions with the early results of the Lewis Research Center GPU-3 tests are compared.

A.R.H.

**N79-16848\*** Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France).

**THE AGARD PROPULSION AND ENERGETICS PANEL 1952-1977**

S. S. Penner (California Univ. at San Diego, La Jolla) Jan. 1978 34 p refs

(AGARD-AR-111; ISBN-92-835-1258-8) Avail: NTIS HC A03/MF A01

Work done during the past 25 years by the AGARD Propulsion and Energetics Panel formerly named Combustion and Propulsion Panel, and initially, Combustion Panel is summarized. The adaptation of the Panel to challenging demands of propulsion technology and the impact of Panel activities on research and development within NATO countries are analyzed. A move in future Panel activities, particularly long term emphasis of energy related topics is suggested. Proposals on publication and publicity policies are included.

A.R.H.

**N79-16850\*** Pratt and Whitney Aircraft, East Hartford, Conn. **ENERGY EFFICIENT ENGINE: PROPULSION SYSTEM-AIRCRAFT INTEGRATION EVALUATION Topical Report.** Mar. 1978 - Sep. 1978

R. E. Owens Mar. 1979 311 p refs

(Contract NAS3-20646)

(NASA-CR-159488; PWA-5594-48) Avail: NTIS HC A14/MF A01 CSCL 21E

Flight performance and operating economics of future commercial transports utilizing the energy efficient engine were assessed as well as the probability of meeting NASA's goals for TSFC, DOC, noise, and emissions. Results of the initial propulsion systems aircraft integration evaluation presented include estimates of engine performance, predictions of fuel burns, operating costs of the flight propulsion system installed in seven selected advanced study commercial transports, estimates of noise and emissions, considerations of thrust growth, and the achievement-probability analysis.

A.R.H.

**N79-16874\*** Lockheed-California Co., Burbank. **Structural and Material Div.**

**FUEL CONSERVATIVE SUBSONIC TRANSPORT**

W. A. Stauffer, R. L. Foss, and J. G. Lewolt In AGARD Active Controls in Aircraft Design Nov. 1978 13 p refs

Avail: NTIS HC A09/MF A01

A fuel saving active control system being developed for commercial application of the L-1011 airplane in the early 1980s is described. Highlighted are features of the TriStar that permit an effective yet simple load relieving system to be adopted. A description of the active control system, which involves integrated movement of both the aileron and horizontal tail, is given. The load relieving benefits obtained and the ability to increase wing span without major structural change are discussed. The potential fuel savings offered by this system is indicated. Comments on the structural design criteria established for the system, the analytic models employed in the active controls analysis, and the initial breadboard control system hardware defined for ground and flight test purposes are included. Also described are ground simulation and flight test plans and results, and thoughts on further application of active controls for future consideration.

J.M.S.

**N79-16892\*** Axiomatix, Marina del Rey, Calif.

**MICROWAVE SYSTEMS ANALYSIS, SOLAR POWER SATELLITE Final Report**

8 Jan. 1979 110 p

(Contract NAS9-15240)

(NASA-CR-160091; R7901-1) Avail: NTIS HC A06/MF A01 CSCL 22B

Various alternative active approaches to achieving and maintaining flatness for the microwave power transmission system (MPTS) were studied. A baseline active alignment scheme was developed which includes subarray attachment mechanisms, height and tilting adjustments, service corridors, a rotating laser beam reference system, monopulse pointing techniques, and the design of a beam-centering photoconductive sensor.

J.M.S.

**N79-16893\*** Department of Energy, Washington, D. C.

**SATELLITE POWER SYSTEM (SPS) PROGRAM SUMMARY**

Dec. 1978 116 p refs

(DOE/ER-0022) Avail: NTIS HC A06/MF A01

In April 1978, a Satellite Power System (SPS) Project office was established in the Office of Energy Research to manage all activities in this program area. The director of the project office focuses on SPS findings, prepares reports and provides recommendations to DOE management with regard to major and national decisions regarding future SPS development. Outlined in this annual Program Summary are: (1) fiscal year 1978 and 1979 summary tables; (2) systems definition studies; (3) environmental assessment studies; (4) societal assessment studies; and (5) comparative assessment studies.

G.Y.

**N79-16895\*** Ozeroff (Michael J.), Pacific Palisades, Calif.

**SATELLITE POWER SYSTEM (SPS) MILITARY APPLICATIONS**

Michael J. Ozeroff Oct. 1978 45 p refs Sponsored by NASA Prepared for PRC Energy Analysis Co., McLean, Va.

(Contract EG-77-C-01-4024)

(NASA-CR-158109; HCP/R-4024-01) Avail: NTIS HC A03/MF A01 CSCL 22A

The potential military role, both offensive and defensive, of a Satellite Power System (SPS) is examined. A number of potential military support possibilities are described. An SPS with military capabilities may have a strong negative impact on international relations if it is not internationalized. The SPS satellite would be vulnerable to military action of an enemy with good space capability, but would experience little or no threat from saboteurs or terrorists, except via the ground controls. The paper concludes with an outline of some of the key issues involved, and a number of recommendations for future study, including some areas for long term efforts.

G.Y.

**N79-16930\*** National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

**EVALUATION OF THE APPLICATION OF SOME GAS CHROMATOGRAPHIC METHODS FOR THE DETERMINATION OF PROPERTIES OF SYNTHETIC FUELS**

Albert C. Antoine Jan. 1979 46 p refs Presented at the Aerospace Meeting, San Diego, Calif., 27-30 Nov. 1978; sponsored by the Soc. of Automotive Engr. (NASA-TM-79035; E-9834) Avail: NTIS HC A03/MF A01 CSCL 21B

The purpose of the investigation was to evaluate the applicability, to some synthetic fuels, of some gas chromatographic methods now under development for use with petroleum based fuels. Thirty-two jet and diesel fuel samples which were prepared from oil shale and coal syncrudes were examined. The boiling range distribution of each was determined by gas chromatography, and from that data distillation properties were calculated. The calculated results gave sufficient agreement with the measured values that the equations could be useable in their present form. Bulk fuel properties were calculated for the sixteen JP-5 and Diesel No. 2 type fuels. The results show that the equations would not give useable results. Capillary column gas chromatography was used to determine the n-alkane content of the eight JP-5 type samples and the results related to the observed freezing points. The results show that the concentrations of the long straight chain molecules in the fuels exert influence on the freezing point but are not the complete controlling factor. L.S.

**N79-16997\*** National Aeronautics and Space Administration, Washington, D. C.

**HYDROGEN TECHNOLOGY FROM THERMONUCLEAR RESEARCH**

*In its* Liquid Hydrogen as a Propulsion Fuel, 1945-1959 1978 p 63-71

Avail: NTIS MF A01; HC SOD CSCL 21D

Under the stimulus of hydrogen bomb development, liquid hydrogen technology advanced rapidly in the first part of the 1950s. A historical review of the scientists and their efforts in advancing this technology from thermonuclear research is presented. The development of the National Cryogenic Engineering Laboratory and mobile liquid hydrogen equipment during this period is discussed. Cryogenic information exchange conferences sponsored by the National Cryogenic Engineering Laboratory are also discussed. G.Y.

**N79-16999\*** National Aeronautics and Space Administration, Washington, D. C.

**NACA RESEARCH ON HYDROGEN FOR HIGH ALTITUDE AIRCRAFT**

*In its* Liquid Hydrogen as a Propulsion Fuel, 1945-1959 1978 p 95-112

Avail: NTIS MF A01; HC SOD CSCL 21D

In 1954, the fuels and propulsion panel of the Scientific Advisory Board met to survey the major aspects of the propulsion program of the Air Force. The panel was greatly interested in high-energy fuels and the Air Force program on them. A proposal was introduced to use hydrogen in a high altitude aircraft powered by a unique engine called Rex 1. This touched off a strong renewal of interest in liquid hydrogen for aircraft. The historical investigations, during 1954-1957, of liquid hydrogen for high altitude aircraft and missiles are discussed. The experiments began with an investigation of low pressure combustion in a single turbojet combustor, extended to other components and complete turbojet engine systems, and culminated in the first (and only) flight experiments. A partial list of the many contributions of this research effort is presented. G.Y.

**N79-17000\*** National Aeronautics and Space Administration, Washington, D. C.

**NEW INITIATIVES IN HIGH ALTITUDE AIRCRAFT**

*In its* Liquid Hydrogen as a Propulsion Fuel, 1945-1959 1978 p 112-139 refs

Avail: NTIS MF A01; HC SOD CSCL 21D

The Air Force began planning work to achieve very-high altitude flight in late 1952. In 1954, a high-altitude reconnaissance

airplane that was sponsored by the government was proposed. This became the U-2 aircraft. In 1954, a novel hydrogen fueled subsonic airplane capable of high-altitude flight was proposed. Although never built, it spawned considerable interest and activity on the potential of hydrogen as a fuel. An account of the contract work undertaken to develop the airplane and its engine is presented. As interest grew and specifications changed from a subsonic to a supersonic airplane the required engine power increased. This meant a much larger hydrogen fueled engine. The growth in engine size effectively took the contractor out of competition. This case history of an inventor and contractor and their frustrations with a single customer (U.S. Government) is analyzed. G.Y.

**N79-17011\*** Purdue Univ., Lafayette, Ind. School of Mechanical Engineering.

**ALTERNATIVE HYDROCARBON FUELS: COMBUSTION AND CHEMICAL KINETICS**

Craig T. Bowman, ed. (Stanford Univ., Calif.) and Jorgen Birkeland, ed. (DOE, Washington, D. C.) Oct. 1978 473 p refs Proc. of a Proj. SQUID Workshop held at Loyola Coll. Conf. Center, Columbia, Md., 7-9 Sep. 1977 Sponsored in part by AFOSR and DOE

(Contract N00014-75-C-1143; Proj. SQUID; NR Proj. 098-038) (AD-A061050; SQUID-PU-R2-78) Avail: NTIS HC A20/MF A01 CSCL 21/4

Contents: Alternative Fuel Availability and Anticipated Combustion Problems; Critical Processes in Combustion of Alternative Fuels; Pyrolysis and Oxidation Kinetics of Alternative Fuels; Pollutant Emissions Considerations for Alternative Fuel Combustion; and Summary and Conclusions. GRA

**N79-17019\*** Transportation Systems Center, Cambridge, Mass. **PROCEEDINGS OF SYMPOSIUM ON WATER-IN-FUEL EMULSIONS IN COMBUSTION Final Report**

Robert Walter, ed. and James White, ed. (Coast Guard, Washington, D.C.) Sep. 1978 220 p refs Symp. held at Cambridge, Mass., 20-21 Apr. 1977

(AD-A061503; TSC-USCG-78-12; USCG-D-12-78) Avail: NTIS HC A10/MF A01 CSCL 21/4

This volume contains the proceedings of a symposium on water-in-fuel emulsions held at the DOT Transportation Systems Center April 20 and 21, 1977. This symposium, sponsored by the DOT's U.S. Coast Guard and Office of the Secretary, provided a forum for researchers involved in the use of water-in-fuel emulsions in combustion. Participants from academia, industry and government contributed papers and discussed the properties, production and utilization of water-in-fuel emulsions in boilers, diesels, and gas turbines. These proceedings contain the abstracts of 18 papers as well as the discussions on these papers and recommendations for needed research in emulsified fuel technology. Also included are a list of attendees and a bibliography on the subject of emulsified fuels. Author (GRA)

**N79-17025\*** Battelle Memorial Inst., Columbus, Ohio. Columbus Labs.

**COMBUSTION OF HYDROTHERMALLY TREATED COALS Final Report, Aug. 1975 - Jun. 1977**

E. P. Stambaugh, R. D. Giammar, and K. C. Sekhar Apr. 1978 156 p refs

(Contract EPA-68-02-2119)

(PB-287521/9; EPA-600/7-78-068)

Avail: NTIS

HC A08/MF A01 CSCL 21D

The report gives results of an evaluation of: (1) the relationship of the combustion characteristics of hydrothermally treated (HTT) coals to environmental emissions, boiler design, and interchangeability of solid fuels produced by the Hydrothermal Coal Process (HCP) with raw coals currently being used as the source of energy; and (2) the conversion of solubilized coal to terephthalic acid. Results indicate that the HTT coals are clean solid fuels that, in many instances, can be burned with little or no sulfur emissions. Flue gas SO<sub>2</sub> concentrations were well below Federal Sulfur Emission Standards for New Sources. The HTT coal was found to burn as well as or better than raw coal.

Trace metals emissions should be significantly reduced because of the lower concentrations in HTT coals. HTT coals appear to be more suitable for firing in wet-bottom than in dry bottom furnaces because of potential fouling and slagging associated with their alkali content. However, additives may possibly be used to reduce fouling and slagging. GRA

**N79-17026#** Hydrocarbon Research, Inc., Lawrenceville, N. J.  
**CATALYST EVALUATION FOR DENITROGENATION OF PETROLEUM RESIDUA AND COAL LIQUIDS, PHASE 5 Progress Report, Sep. 1975 - Feb. 1978**

Cecelia C. Kang and Jeffrey Gendler Aug. 1978 57 p  
 (Contract EPA-68-02-0293)

(PB-287180/4; EPA-600/7-78-159) Avail: NTIS  
 HC A04/MF A01 CSCL 21D

The catalysts for demetalization of heavy residual oils and for denitrogenation were studied. Some commercial catalysts for denitrogenation activity in petroleum residua and coal liquids were evaluated and an improved catalyst for denitrogenation of heavy coal liquids was developed. Under one task, two commercial catalysts failed to reduce nitrogen content of a petroleum vacuum residual from 0.67% to the 0.3% target. The observed catalyst deactivation rate is similar to that of catalysts with similar pore structures which are being used for hydrodesulfurization of petroleum residual. Under another task, attempts to denitrogenate heavy coal-derived liquids with commercial Co-Mo catalysts pointed to the need for improved catalysts. In the task to improve catalysts, Ni-Mo was identified as a better active metal pair than Co-Mo or Ni-W for denitrogenation of coal liquids. GRA

**N79-17027#** Research Triangle Inst., Research Triangle Park, N. C.

**POLLUTANTS FROM SYNTHETIC FUELS PRODUCTION: FACILITY CONSTRUCTION AND PRELIMINARY TESTS Phase Report, Nov. 1976 - Apr. 1978**

J. G. Cleland, F. O. Mixon, D. G. Nichols, C. M. Sparacino, and D. E. Wagoner Aug. 1978 128 p refs  
 (Grant EPA-R-804979)

(PB-287730/6; EPA-600/7-78-171) Avail: NTIS  
 HC A07/MF A01 CSCL 07D

The factors and conditions that cause the production of environmental pollutants in synthetic fuel processes were investigated. Tasks described include: operation of a laboratory-scale coal gasification facility; collection and chemical analysis of effluent stream samples; compilation and analysis of resulting data; and evaluation of these data. The experimental system operates successfully and reliably at gasification temperatures up to 1370 K, pressures up to 1.2 MPa, and gas generation rates of about 20 standard liters/min. The major pollutant classes are benzene and its substituents, thiols and sulfides, phenols, fused polycyclics, sulfur heterocyclics, and inorganic sulfur compounds. GRA

**N79-17118#** Defence Research Establishment, Ottawa. (Ontario).  
**POWER SUPPLIES FOR ARCTIC RADIO REPEATER SYSTEMS**

Gerald D. Nagy Sep. 1978 50 p refs  
 (AD-A061609; DREO-R-787) Avail: NTIS HC A03/MF A01 CSCL 17/2

This feasibility study assesses various long lived, self-contained 30 watt power supplies for an Arctic Radio Repeater System. The study involves a review of the state-of-the-art, availability and cost of five candidate systems; batteries, fuel cells; radioisotopic thermoelectric generators, fueled thermoelectric generators and windmill-battery systems. The above five candidates were also assessed as standby power units. Reliability, service and maintenance requirements are considered since the application calls for one year unattended operation and servicing by light helicopter on a single annual flight for all sites. Only zinc/air batteries with lead/acid batteries for the standby system are available now. Their cost is moderate, but zinc/air cells are heavy and must be replaced each year. Other systems could be available in the 1980's but they would require various amounts of development work and evaluation in an arctic environment.

Recommendations and priorities for development of the systems which could replace the zinc/air cells at a later date are given.

Author (GRA)

**N79-17230#** Aeronautical Research Labs., Melbourne (Australia).  
**TESTS OF WISCONSIN S12D ENGINE RUNNING ON NATURAL GAS WITH ADDITION OF CARBON DIOXIDE**  
 B. G. Catchpole and T. S. Keeble May 1978 14 p refs  
 (AD-A058486; ARL/MECH-ENG-TM-391) Avail: NTIS  
 HC A02/MF A01 CSCL 21/7

Natural gas or bio-gas are possible alternative fuels to petrol in Otto-cycle engines. A commercial, single-cylinder, spark-ignition engine has been run on various mixtures of natural gas with carbon dioxide to gain experience of its operation and compare its behaviour with operation using petrol. While there was a considerable drop in power with straight natural gas, the specific fuel consumption was not greatly affected. No attempt was made to advance the spark timing or to increase the compression ratio although both of these changes would be expected to improve the performance considerably. When operating on gas, it was found possible to vary the power of the engine over a wide range by varying the mixture strength, as in a diesel. Performance was little affected by increase of carbon dioxide content up to 47%. Author (GRA)

**N79-17289#** Tennessee Univ. Space Inst., Tullahoma. Remote Sensing Div.

**APPLYING NASA REMOTE SENSING DATA TO GEOLOGICALLY RELATED REGIONAL PLANNING PROBLEMS IN TENNESSEE Final Report**

1978 70 p Workshop held at Tullahoma, Tenn., 10-11 Mar. 1978 ERTS

(Contract NAS8-32034)

(E79-10095; NASA-CR-150866) Avail: NTIS  
 HC A04/MF A01 CSCL 08G

There are no author-identified significant results in this report.

**N79-17281#** Zentralstelle fuer Geo-Photogrammetrie und Fernerkundung, Munich (West Germany).

**APPLICATION OF LANDSAT DATA AND DIGITAL IMAGE PROCESSING Technical Report, 1975 - 1978**

J. Bodechtel, Principal Investigator May 1978 169 p refs  
 Sponsored by NASA Original contains color imagery. Original photography may be purchased from the EROS Data Center, Sioux Falls, S. D. 57198 ERTS

(E79-10102; NASA-CR-158058) Avail: NTIS  
 HC A08/MF A01 CSCL 05B

The author has identified the following significant results. Based on LANDSAT 1 and 2 data, applications in the fields of coal mining, lignite exploration, and thematic mapping in geology are demonstrated. The hybrid image processing system, its software, and its utilization for educational purposes is described. A pre-operational European satellite is proposed.

**N79-17309#** Fish and Wildlife Service, Fort Collins, Colo. Western Energy and Land Use Team.

**RESERVOIR ECOSYSTEMS AND WESTERN COAL DEVELOPMENT IN THE UPPER MISSOURI RIVER BASIN Summary Report**

William Nelson Jul. 1978 16 p  
 (PB-287363/6; FWS/OBS-78/25) Avail: NTIS  
 HC A02/MF A01 CSCL 13B

An ecological overview evaluating the limnology, water chemistry and fisheries of lakes Fort Peck and Sakakawea is presented. Specifically, the survey provides an overview of baseline conditions, describes various developments and their impacts, identifies mitigation measures, and delineates further research needs. Additionally, the data collected over the study year from the two upper impoundments, Lake Peck and Lake Sakakawea, is compared with the more comprehensive data compiled over a period of several years on the lower four reservoirs to determine the extent of the physical, chemical and biological similarity among the respective systems. GRA

**N79-17311#** NALCO Environmental Sciences, Northbrook, Ill.  
**ATLAS OF WESTERN SURFACE-MINED LANDS: COAL, URANIUM, AND PHOSPHATE**

A. Kent Evans, E. W. Uhleman, and P. A. Eby Jan. 1978  
 396 p refs  
 (Contracts D1-14-13-0009-77-004; EPA-IAG-D6-E695)  
 (PB-287846/0; FWS/OBS-78/20; LC-78-600096) Avail:  
 NTIS HC A17/MF A01 CSCL 081

The atlas contains available information on all coal, uranium, and phosphate surface mines in excess of 10 acres that were in operation prior to 1976 in the western 11 contiguous states plus North Dakota and South Dakota. It is assembled in a format that allows a systematic and comprehensive review of surface-mined lands so that appropriate areas can be selected for intensive biological assessment of natural and man-induced revegetation and reforestation. GRA

**N79-17316#** Council for Scientific and Industrial Research, Pretoria (South Africa).

**SYMPOSIUM ON ENERGY TODAY AND TOMORROW**  
 1977 185 p refs Symp. held at Pretoria, October 1977  
 (CSIR-S-145) Avail: NTIS HC A09/MF A01

The demand and supply of energy sources in the near future are discussed. Coal processing plant designs are reviewed for South Africa and Australia. The development of alternate energy sources, such as solar and nuclear, is also considered.

**N79-17317#** Atomic Energy Board, Pretoria (South Africa).  
**NUCLEAR POWER TODAY AND TOMORROW**

K. T. Brown In CSIR Symp. on Energy Today and Tomorrow 1977 11 p ref  
 Avail: NTIS HC A09/MF A01

A realistic assessment of the contribution which nuclear power is making now, and can make in the future, towards satisfying global energy demands is presented. Global reserves of nuclear fuel are relatively small in terms of utilization by current commercial technology. In the long term the intrinsic value of nuclear fuel reserves may be multiplied many times by technological developments, but a number of factors will be of influence in realizing such enhancement. Social, political and economic parameters have slowed the projected growth of nuclear power in recent years. The aftermath of the oil dislocation and price rises is not yet over, and future tendencies remain difficult to predict in the prevailing general atmosphere of unwarranted complacency regarding energy supplies. J.A.M.

**N79-17318#** Council for Scientific and Industrial Research, Pretoria (South Africa).

**COAL PREPARATION DESIGN FOR EXPORT MARKETS, WITH PARTICULAR REFERENCE TO SOUTH AFRICAN AND CANADIAN COALS**

S. G. Butcher (Simon-Carves of Canada Limited) In its Symp. on Energy Today and Tomorrow 1977 22 p refs

Avail: NTIS HC A09/MF A01

South African and Canadian coals are described, including their washability characteristics and extremely fine size. Plant design factors, test work validity, process optimization, and plant flexibility are reviewed. Environmental and contractual limitations are also cited. J.A.M.

**N79-17319#** Council for Scientific and Industrial Research, Pretoria (South Africa).

**INFLUENCE OF MARKETING REQUIREMENTS ON DEFINITION OF COAL RESOURCES**

F. Pollard (Australian Coal Industry Research Labs. Ltd.) In its Symp. on Energy Today and Tomorrow 1977 12 p

Avail: NTIS HC A09/MF A01

A method of examination of borecores was developed which was especially designed to provide data that can be used for the evaluation of the preparation requirements of the output of a future mine. Samples can also be prepared from the borecores which simulate the future marketable product to a close degree

particularly with regard to screen analysis and to vitrinite and mineral matter distribution throughout the particle size range. The use of this technique for examination of borecores has reduced the time required to assess a coal deposit and provides data from the laboratory oriented to the practical situation which will exist when the mine is opened. Decisions on mine planning, marketable coal quality, utilization and the necessary preparation systems in some areas of Australia were based entirely upon the laboratory evaluation of borecore samples. J.A.M.

**N79-17320#** American Gas Association, Inc., Arlington, Va.  
**DIRECTION OF GAS SUPPLY RESEARCH IN THE US**

Ab Flowers In CSIR Symp. on Energy Today and Tomorrow 1977 11 p

Avail: NTIS HC A09/MF A01

Research was accelerated to increase supplies from supplemental sources, such as, enhanced recovery of tight formations, gas from coal seams, and coal gasification. Research is also underway to develop supplies of gaseous fuels for the long term. Development of second generation coal technology (hydrogen from water and methane from marine biomass) is discussed. J.A.M.

**N79-17321#** Council for Scientific and Industrial Research, Pretoria (South Africa).

**COAL GASIFICATION AND SOUTH AFRICA**

D. Clark (Fuel Research Inst. of South Africa) In its Symp. on Energy Today and Tomorrow 1977 29 p refs

Avail: NTIS HC A09/MF A01

Lacking the cheap indigenous hydrocarbon resources of the Western World, South Africa has continued to generate fuel and process gases from its relatively cheap coal. This has helped towards a measure of strategic and economic self sufficiency. The current status of the technology, some of its problems, and its future potential are reviewed. J.A.M.

**N79-17322#** Council for Scientific and Industrial Research, Pretoria (South Africa).

**ENERGY REQUIREMENTS FOR PRODUCING STEEL IN THE REPUBLIC OF SOUTH AFRICA**

W. J. Sander (Fuel Research Inst. of South Africa, Pretoria) In its Symp. on Energy Today and Tomorrow 1977 21 p refs

Avail: NTIS HC A09/MF A01

Available information on the energy requirements for producing steel is reviewed. The blast furnace route, using conventional coke as a fuel, is discussed. Two different alternative routes are subsequently examined namely: (1) the use of formcoke instead of conventional coke in the blast furnace, and (2) the elimination of the blast furnace by applying direct reduction processes. The energy requirements for the application of the different routes are compared. J.A.M.

**N79-17323#** Council for Scientific and Industrial Research, Pretoria (South Africa).

**DESCRIPTION OF HYDRO-ELECTRIC DEVELOPMENT AND PROPOSAL FOR FUTURE DEVELOPMENT ON THE ZAMBEZI**

E. M. Shepherd (Central African Power Corp.) In its Symp. on Energy Today and Tomorrow 1977 15 p

Avail: NTIS HC A09/MF A01

The Zambezi River and its hydro-electric potential are examined with particular reference to the stretch of river forming the boundary between Rhodesia and Zambia on which there is a potential of some 5,500MW and 35,000 million kWh per annum. The present state of development and of possible future development are described. J.A.M.

**N79-17324#** Council for Scientific and Industrial Research, Pretoria (South Africa).

**LOW-TEMPERATURE APPLICATION OF SOLAR ENERGY IN SOUTH AFRICA**

W. N. Cawood and M. Johnson *In its Symp. on Energy Today and Tomorrow* 1977 32 p refs

Avail: NTIS HC A09/MF A01

The suitability of solar energy is demonstrated in the area of low temperature applications, such as water and space heating, and low temperature process heating for industry and agriculture. How much energy from conventional sources could be saved in the domestic sector is also indicated. J.A.M.

**N79-17325#** Council for Scientific and Industrial Research, Pretoria (South Africa).

**THE PLANNING AND ECONOMIC ASPECTS OF ENERGY SUPPLY AND DEMAND IN SOUTH AFRICA**

D. J. Kotze (Department of Planning and the Environment) *In its Symp. on Energy Today and Tomorrow* 1977 12 p

Avail: NTIS HC A09/MF A01

The energy problem is essentially international in character and a brief diagnosis of the world energy situation is made. From this, it appears that a growing imbalance between world energy supply and demand is developing which must inevitably lead to, what is called, the real energy crisis. No country, not even South Africa, can isolate itself from these events. Elements in this conflict situation are analyzed, and recommendations are made. Author

**N79-17326#** Council for Scientific and Industrial Research, Pretoria (South Africa).

**ENERGY TODAY AND TOMORROW**

I. Fells *In its Symp. on Energy Today and Tomorrow* 1977 11 p

Avail: NTIS HC A09/MF A01

World wide, there is a glut of energy which has inhibited the implementation of energy conservation programs. If world energy demand growth continues at 5 per cent per annum, the position will quickly change and serious shortages of oil and gas will arise in the mid 1980's. Deficiencies in energy supply cannot be made up by nuclear power or coal as expansion programs are already slipping badly. This may have been rectified by 2000 but a massive investment in nuclear, coal, and alternative energy resources will be necessary if only a modest growth in energy demand is to be maintained. The high growth of the last 20 years cannot be sustained into the next century. Author

**N79-17328#** Wyle Labs., Inc., Huntsville, Ala. Solar Energy Systems Div.

**LONG TERM WEATHERING EFFECTS ON THE THERMAL PERFORMANCE OF THE SUNWORKS (LIQUID) SOLAR COLLECTOR**

Jan. 1979 11 p refs Prepared for DOE

(Contract NAS8-32036)

(NASA-CR-150899) Avail: NTIS HC A02/MF A01 CSCL 10A

The test procedures used and the results obtained during the evaluation test program of the Sunworks single-covered liquid solar collector are presented. The tests were performed under simulated conditions, following long-term exposure to natural weathering conditions. The sunworks collector is a flat-plate solar collector. The absorber plate is copper with copper tubes bonded by soft solder, and is coated with Enthon selective black with an absorptivity factor of .87 similar to .92 and an emissivity factor of .10 similar to .20. It has a single glass cover of 3/16 inches tempered glass and weighs about 115 pounds. The overall dimensions of the collector are 36 x 84 x 4 inches. G.Y.

**N79-17329#** California Univ., Berkeley. Lawrence Berkeley Lab.

**ENERGY CONSERVATION: POLICY ISSUES AND END-USE SCENARIOS OF SAVINGS POTENTIAL PART 1: SUMMARY**

Sep. 1978 46 p 6 Vol.

(Contract W-7405-eng-48)

(LBL-7896) Avail: NTIS HC A03/MF A01

The following topics are discussed: (1) energy efficient buildings; (2) energy efficient recreational travel; (3) policy barriers and investment decisions in industry; (4) tradeoffs of municipal solid waste processing alternatives; and (5) end-use energy conservation data base and scenarios. G.Y.

**N79-17331\*# CALMAC Mfg. Co., Englewood, N. J. CERTIFICATION REPORT FOR THE CALMAC SOLAR POWERED PUMP**

Dec. 1978 40 p Prepared for DOE

(Contract NAS8-32253)

(NASA-CR-150872) Avail: NTIS HC A03/MF A01 CSCL 10A

The certification of the CALMAC solar powered thermopump is presented. Each element of the specification is delineated, together with the verification, based on analysis, similarity, inspection, or testing. J.M.S.

**N79-17332\*#** Owens-Illinois, Inc., Toledo, Ohio.

**PRELIMINARY DESIGN PACKAGE FOR SUNAIR SEC-601 SOLAR COLLECTOR**

Dec. 1978 60 p Prepared for DOE

(Contract NAS8-32259)

(NASA-CR-150875) Avail: NTIS HC A04/MF A01 CSCL 10A

The preliminary design of the Owens-Illinois model Sunair SEC-601 tubular air solar collector is presented. Information in this package includes the subsystem design and development approaches, hazard analysis, and detailed drawings available as the preliminary design review. G.Y.

**N79-17333\*#** National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

**A 200-kW WIND TURBINE GENERATOR CONCEPTUAL DESIGN STUDY**

Jan. 1979 111 p refs

(Contract E(49-26)-1028)

(NASA-TM-79032: DOE/NASA/1028-79/1) Avail: NTIS HC A06/MF A01 CSCL 10B

A conceptual design study was conducted to define a 200 kW wind turbine power system configuration for remote applications. The goal was to attain an energy cost of 1 to 2 cents per kilowatt-hour at a 14-mph site (mean average wind velocity at an altitude of 30 ft.) The costs of the Clayton, New Mexico, Mod-OA (200-kW) were used to identify the components, subsystems, and other factors that were high in cost and thus candidates for cost reduction. Efforts devoted to developing component and subsystem concepts and ideas resulted in a machine concept that is considerably simpler, lighter in weight, and lower in cost than the present Mod-OA wind turbines. In this report are described the various innovations that contributed to the lower cost and lighter weight design as well as the method used to calculate the cost of energy. Author

**N79-17335\*#** National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

**EVALUATION OF THE ECAS OPEN CYCLE MHD POWER PLANT DESIGN Final Report**

George R. Seikel, Peter J. Staiger, and Carlson C. P. Pian Nov. 1978 27 p refs Prepared for DOE

(Contract EF-77-A-01-2674)

(NASA-TM-79012, E-9799; DOE/NASA/2674-78/2) Avail: NTIS HC A03/MF A01 CSCL 10B

The Energy Conversion Alternatives Study (ECAS) MHD/steam power plant is described. The NASA critical evaluation of the design is summarized. Performance of the MHD plant is compared to that of the other type ECAS plant designs on the basis of efficiency and the 30-year levelized cost of electricity. Techniques to improve the plant design and the potential performance of lower technology plants requiring shorter development time and lower development cost are then discussed. Author

N79-17336

**N79-17336\*** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.  
**PHOTOVOLTAIC TESTS AND APPLICATIONS PROJECT**  
**Final Progress Report, Apr. 1976 - Jun. 1977**  
Nov. 1978 90 p refs  
(Contract E(49-26)-1022)  
(NASA-TM-79018; E-9811; DOE/NASA/1022-78/42) Avail:  
NTIS HC A05/MF A01 CSCL 10A

The activities and accomplishments of the Photovoltaic Tests and Applications Project during the period April 1976 through June 1977 are summarized. Results of efforts to identify potential near-term photovoltaic applications and users are discussed, including the outcome of an extensive survey of Federal government agencies. The status of application experiments is presented. Various general engineering efforts are reported, including the design and construction of a photovoltaic Systems Test Facility. Efforts to develop a high efficiency 10 kVA self-commutated inverter and controller specifically designed for photovoltaic systems are also discussed. The results of a wide variety of activities in the area of photovoltaic measurements and standards are related. Documents generated by the Project during the reporting period are listed in an Appendix. G.Y.

**N79-17337\*** California Univ., Livermore. Lawrence Livermore Lab.

**COMPARATIVE COST ANALYSES: TOTAL FLOW VS OTHER POWER CONVERSION SYSTEMS FOR THE SALTON SEA GEOTHERMAL RESOURCE**

Gerald W. Wright 18 Sep. 1978 35 p refs  
(Contract W-7405-eng-48)  
(UCRL-52589) Avail: NTIS HC A03/MF A01

Cost studies were done for Total Flow, double flash, and multistage flash binary systems for electric energy production from the Salton Sea Geothermal Resource. The purpose was to provide the Department of Energy's Division of Geothermal Energy with information by which to judge whether to continue development of the Total Flow system. Results indicate that the Total Flow and double flash systems have capital costs of \$1,135 and \$1,026 /kW with energy costs of 40.9 and 39.7 mills/kW hr, respectively. The Total Flow and double flash systems are not distinguishable on a cost basis alone; the multistage flash binary system, with capital cost of \$1,343 /kW and energy cost of 46.9 mills/kW hr., is significantly more expensive. If oil savings are considered in the total analysis, the Total Flow system could save 30% more oil than the double flash system--\$3.5 billion at 1978 oil prices. Author

**N79-17338\*** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

**DEVELOPMENT, TESTING, AND CERTIFICATION OF CALMAC MFG. CORP. SOLAR COLLECTOR AND SOLAR OPERATED PUMP Final Report**

John C. Parker Jan. 1979 30 p refs Prepared for DOE  
(NASA-TM-78218) Avail: NTIS HC A03/MF A01 CSCL 10A  
Development of a rubber tube solar collector and solar operated pump for use with solar heating and cooling systems is discussed. The development hardware, problems encountered during fabrication and testing, and certification statements of performance are included. J.M.S.

**N79-17339\*** Committee on Science and Technology (U S. House).

**RESEARCH AND DEVELOPMENT NEEDS TO MERGE ENVIRONMENTAL AND ENERGY OBJECTIVES**

Robert E. Trumbule, Joseph P. Biniek, John E. Blodgett, and Carl E. Behrens Washington GPO 1978 270 p refs Rept. for Subcomm. on the Environment and the Atmosphere of the Comm. on Sci. and Technol., 95th Congr., 2d Sess., Mar. 1978 Prepared by the Library of Congr., Congressional Res. Service (GPO-23-254) Avail: SOD HC

A preliminary report, based on FY 1976 funding data, was completed in October 1977. This report is an extension of the earlier report; the major objective is to focus upon the interrelationships between the environment and energy development and use. A summary of FY 1977 R and D funding in the matrix format developed in the earlier study is presented. A

series of environmental-energy issues are defined and a number of questions for each are posed. Two appendices are included: (1) a brief discussion of environmental factors that are included in the matrix and a discussion of the respective fuel cycles; (2) a summary of hearings on the coal and nuclear fuel cycles held before the Subcommittee on the Environment and the Atmosphere. G.Y.

**N79-17340\*** UOP, Inc., Des Plaines, Ill.  
**OPTIMIZATION OF P1DOPED KOCITE (TRADE NAME) ELECTRODES IN H3PO4 FUEL CELLS Interim Progress Report, 28 Jan. 1978 - 28 Jul. 1978**

L. B. Welsh, R. W. Leyerly, and D. M. Preston Aug. 1978 54 p refs  
(Contract DAAG53-76-C-0014; DA Proj. 1G7-62708-AH-67)  
(AD-A061242; IPR-5) Avail: NTIS HC A04/MF A01 CSCL 10/2

The use of UOP Inc. Kocite electrocatalysts as low-cost air and/or fuel electrocatalysts in phosphoric acid electrolyte fuel cells is being optimized with respect to some of the electrocatalyst and electrode structure parameters. Kocite electrocatalysts are made from Kocite materials, which are composite structures consisting of pyropolymers chemically bonded to refractory substrates. Fuel cell electrodes are fabricated from these electrocatalysts and normally tested as anodes and cathodes in model fuel cells. GRA

**N79-17341\*** Burns and Roe, Inc., Woodbury, N. Y.  
**USAF TERRESTRIAL ENERGY STUDY. VOLUME 3. PART 1: SUMMARY DATA DISPLAY Final Report, 1 Apr. 1978 - 1 Feb. 1978**

David C. Hall, A. Carlson, D. Fuller, R. Reyer, C. Mallner, S. Fogelson, and M. Novak May 1978 390 p refs  
(Contract F33615-76-C-2171; AF Proj. 3145)  
(AD-A061071; AFAPL-TR-78-19-Vol-3-Pt-1) Avail: NTIS HC A17/MF A01 CSCL 10/2

This report was prepared to serve as a guide for the U.S. Air Force in selecting types of energy conversion systems to meet their future ground power requirements. The electric power requirements included in this report range from 10 kilowatts to 50 megawatts. Twenty-one types of systems, conventional as well as advanced, are considered. These include 19 types of energy conversion systems which utilize either chemical fuel, nuclear fuel, solar energy or wind energy and two types of energy storage systems which utilize electric power for recharging. Each system is characterized in terms of a set of economic, physical and performance parameters including acquisition costs, life cycle costs, size, efficiency and environmental constraints. A total of eighteen such parameters are presented for each type of system for several sets of requirements. The requirements are defined in terms of electric power level, voltage level, frequency and duration of operation corresponding to typical U.S. Air Force ground applications. GRA

**N79-17344\*** Brown, Boveri und Cie, A.G., Heidelberg (West Germany). Zentrales Forschungslab.

**DEVELOPMENT OF HIGH TEMPERATURE FUEL CELL BATTERY Final Report**

Hubert Holick, Herbert Kleinschmager, Rudolf Krapf, Armin Minor, and Franz-Josef Rohr Dec. 1977 265 p refs In GERMAN; ENGLISH summary Sponsored by Bundesmin. fuer Forsch. u. Technol.

(BMFT-FB-T-77-17) Avail: NTIS HC A12/MF A01; ZLDI, Munich DM 57.10

Proceeding from the basic investigation of single cells, research work was performed with high temperature fuel cell batteries containing ZrO2 solid electrolytes. The main objective was to develop multicell modules and the associated joining technology as well as the development of auxiliary equipment for the operation of the batteries. Modules of 30 tube-shaped in-series connected cells and the subsequently built small battery units as well as the auxiliary equipment necessary for the reformation of natural gas were tested successfully at working temperatures of 1000 C. Experimental cells were operated for more than 22,000 hours at temperatures of 1000 C and under

permanent load. The decrease in voltage and performance was minimal. G.Y.

**N79-17348#** National Technical Information Service, Springfield, Va.

**SOLAR WATER PUMPS. CITATIONS FROM THE ENGINEERING INDEX DATA BASE Progress Report, 1970 - Nov. 1978**

Audrey S. Hundemann Dec. 1978 46 p  
(NTIS/PS-78/1288/6; NTIS/PS-77/1161) Avail: NTIS HC \$28.00/MF \$28.00 CSCL 02C

Design concepts and the technical and economic feasibility of using solar energy to pump water are discussed. The use of solar heat actuated Rankine cycle engines and free cylinder Stirling engines for solar powered water pumps, pumps driven by photovoltaic modules, and application of solar pumps to irrigation and electric power generation were studied. This updated bibliography contains 40 abstracts, 9 of which are new entries to the previous edition. GRA

**N79-17349#** Rutgers - The State Univ., Piscataway, N. J. Dept. of Electrical Engineering.

**SILICON SCHOTTKY PHOTOVOLTAIC DIODES FOR SOLAR ENERGY CONVERSION Annual Progress Report, 1 Jan. - 31 Dec. 1977**

Wayne A. Anderson Jan. 1978 5 p refs Prepared in cooperation with ERDA, Washington, D. C.  
(Contract NSF AER-73-03197)

(PB-287417/0; NSF/RANN/SE/AER73-03197/PR-77; NSF/RA-780267) Avail: NTIS HC A02/MF A01 CSCL 10B

Work accomplished on a research study involving a five fold plan to achieve 12.5 percent efficiency and apply the Schottky process to more economical silicon substrates is reported. A study of the interfacial insulating layer was made to correlate layer thickness and composition with solar cell performance. Scanning electron microscope and Auger spectrographic analyses were used with electronic tests to investigate this effect. Processing variables were studied using substrate heating, substrate biasing, and sputtered-top metal layers. The Schottky process was applied to ribbon silicon and polysilicon to investigate the efficiency as applied to continuous fabrication techniques. GRA

**N79-17350#** National Bureau of Standards, Washington, D. C. Solar Criteria and Standards Program.

**ENVIRONMENTAL AND SAFETY CONSIDERATIONS FOR SOLAR HEATING AND COOLING APPLICATIONS**

Sep. 1978 34 p refs Sponsored in part by HUD

(Contract DOE-EA-77-A-01-6010)

(PB-287772/8; NBSIR-78-1532) Avail: NTIS HC A03/MF A01 CSCL 13A

The HUD Minimum Property Standards (MPS) and the residential and commercial interim performance criteria (IPC) prepared by the National Bureau of Standards address many health and safety considerations that need to be considered by solar heating and cooling system designers. For example, factors such as the toxicity and flammability of heat transfer fluids are often not considered in the design of systems. Similarly, attention is seldom paid to the safe disposal of these fluids. These problems are compounded by the lack of clear guidelines as to which fluids constitute hazards that warrant special consideration. This report is intended to create an increased sense of awareness of the health and safety aspects of solar heating and cooling applications by extracting and amalgamating pertinent provisions of the MPS and IPC documents. Some of the areas that are addressed include: structural safety, heat transfer fluid toxicity and flammability considerations including the protection of potable water, effects of solar equipment on the fire resistance of buildings, and protection from physical hazards. GRA

**N79-17351#** National Bureau of Standards, Washington, D. C. Building Economics and Regulatory Technology Div.

**STATE-OF-THE-ART STUDY OF HEAT EXCHANGERS USED WITH SOLAR ASSISTED DOMESTIC HOT WATER SYSTEMS (POTENTIAL CONTAMINATION OF POTABLE WATER SUPPLY) Final Report**

F. Eugene Metz and Mary Jane Orloski Oct. 1978 82 p refs Sponsored in part by DOE

(PB-287410/5; NBSIR-78-1542) Avail: NTIS HC A05/MF A01 CSCL 13A

The results are presented of a nonquantitative state-of-the-art with solar assisted domestic hot water systems where a heat exchanger interface exists between the potable water supply and heat transfer fluid. Emphasis is placed on the potential for contaminating the potable water supply if failures should occur. The study considers (1) characteristics of various heat exchanger types and their relative safety; (2) characteristics of heat exchanger fluids (toxicity, corrosivity, thermal properties, etc.); (3) regulatory considerations; and (4) designs of similar systems with potential for contamination. GRA

**N79-17352#** National Bureau of Standards, Washington, D. C. Electron Devices Div.

**MEASUREMENT TECHNIQUES FOR SOLAR CELLS Quarterly Report, 1 Jan. 1978 - 31 Mar. 1978**

D. E. Sawyer, H. K. Kessler, and H. A. Schafft Sep. 1978 18 p refs Sponsored in part by DOE

(PB-287519/3; NBSIR-78-1513) Avail: NTIS HC A02/MF A01 CSCL 10B

A technique is set forth which employs forward-biasing solar cells during scanning to pin-point certain cell defects and to obtain values of cell quantities such as emitter sheet resistance. An analysis appropriate for laser scanning forward-biased cells with a line source is presented. Results from initial experiments suggest that the new technique should work quite well on real-world solar cells. Apparatus development work included the design and initial construction of a high-sun insolation source for forward-biasing cells by light while scanning, and the construction of a matching network to couple the low-impedance illuminated cell to the scanned display electronics. The announcement and program for the May 1-3, 1978 Workshop on the Stability of (Thin Film) Solar Cells and Materials at NBS is presented. GRA

**N79-17353#** Pennsylvania State Univ., University Park. Inst. for Research on Land and Water Resources.

**WATER/ENERGY MANAGEMENT AND EVALUATION MODEL FOR PENNSYLVANIA Completion Report**

Terrence L. Elchak, David L. Raphael, James P. Ignizio, and Hector H. Martinez Sep. 1978 146 p refs

(Contract DI-14-34-0001-7080; OWRT Proj. A-048-PA(3))  
(PB-287577/1; W79-00007) Avail: NTIS HC A07/MF A01 CSCL 10A

An interactive water/energy model is presented for the state of Pennsylvania. An independent water model and energy model are joined to show the interactions between energy supply and demand with the supply of water. These interactions are depicted by water use functions for various energy sectors. Specific examples are presented for the electrical generation sectors. Two hypothetical scenarios are presented to show the use of the model as a planning tool. GRA

**N79-17354#** Rosenstiel School of Marine and Atmospheric Sciences, Miami, Fla. Div. of Biology and Living Resources.  
**PHOTOPRODUCTION OF HYDROGEN BY MARINE BLUE-GREEN ALGAE Annual Progress Report, 15 Dec. 1977 - 15 Jun. 1978**

Akira Mitsui 15 Jun. 1978 71 p refs

(Grant NSF AER-77-11545)

(PB-287508/6; NSF/RA-780272) Avail: NTIS HC A04/MF A01 CSCL 06A

The biological and biochemical photoproduction of hydrogen was studied for use as an alternate fuel. Earlier investigations found an organism which exhibits exceptionally high hydrogen producing capabilities in the form of a blue-green algal strain, Miami BG7.F were performed to reveal the mechanisms of

hydrogen production in this strain and to determine whether the efficiency of hydrogen production can attain levels required for applied projects. Emphasis in research shifted from the study of metabolic inhibitors of hydrogen production to a study of the enzyme systems which catalyze hydrogen production. It was discovered that hydrogen evolution by Miami BG7 involves the participation of both hydrogenase and nitrogenase, with the latter appearing as the major contributor of the hydrogen production. However, Miami BG7 does not appear to exhibit hydrogenase activity. The effects of light intensity, temperature, and pH were tested and optimum conditions for hydrogen photoproduction were determined. It was found that the regulation of specific environmental parameters could lead to marked changes in the quantum efficiency of hydrogen production. A brief background review and discussion of hydrogen photoproduction is given with an approach to hydrogen production research. GRA

**N79-17364#** Hittman Associates, Inc., Columbia, Md.  
**ENVIRONMENTAL ASSESSMENT DATA BASE FOR COAL LIQUEFACTION TECHNOLOGY. VOLUME 1: SYSTEMS FOR 14 LIQUEFACTION PROCESSES** Final Report, Feb. 1977 - Aug. 1978

Craig S. Koralek and Subhash S. Patel Sep. 1978 204 p refs 2 Vol.  
 (Contract EPA-68-02-2162)  
 (PB/287799/1; EPA-600/7-78-184A) Avail: NTIS  
 HC A10/MF A01 CSCL 07A

Pertinent information about 14 prominent coal liquefaction systems now being developed are summarized. For each system, a brief description, a flow diagram, and a list of materials entering and leaving the system is presented. Potential applicable control techniques are described generally, along with the current status and development plans for the 14 systems. Results indicate that these processes are not environmentally defined in the published literature; however, there is some indication that current development plans may help to correct this situation. GRA

**N79-17365#** Hittman Associates, Inc., Columbia, Md.  
**ENVIRONMENTAL ASSESSMENT DATA BASE FOR COAL LIQUEFACTION TECHNOLOGY. VOLUME 2: SYNTHOIL, H-COAL, AND EXXON DONOR SOLVENT PROCESSES** Final Report, Feb. 1977 - Aug. 1978

C. Leon Parker and Dewey I. Dykstra Sep. 1978 482 p refs 2 Vol.  
 (Contract EPA-68-02-2162)  
 (PB-287800/7; EPA-600/7-78-184B) Avail: NTIS  
 HC A21/MF A01 CSCL 07A

An environmental characterization of three selected coal liquefaction systems: Synthoil, H-Coal, and Exxon Donor Solvent are presented. Existing environmentally significant data are documented and evaluated. Estimates are given for the raw waste streams, treatment and control processes, treated waste stream discharges, and the effects of these discharges on the environment. Conclusions include: (1) carbon-containing residues from process phase separations are major potential environmental problems; (2) except for solid carbon-containing residues from phase separations, treatment and controls exist for removing most major waste components--however, their efficiency in controlling coal liquefaction waste streams needs to be tested; and (3) less attention was addressed to trace organic and inorganic compounds. GRA

**N79-17366#** National Oceanic and Atmospheric Administration, Boulder, Colo.  
**ENVIRONMENTAL ASSESSMENT OF THE ALASKAN CONTINENTAL SHELF. VOLUME 1: BIOLOGICAL STUDIES** Final Reports

Jun. 1978 494 p refs Sponsored in part by Bureau of Land Management 3 Vol.  
 (PB-289154/7; NOAA-78110701) Avail: NTIS  
 HC A21/MF A01 CSCL 13B

The aquatic fauna and ecology of the Alaskan Continental Shelf which assess the environmental effects of petroleum developments in the area are reported. Lethal and sublethal effects on selected Alaskan marine species after acute and long-term exposure to oil and oil components; food and feeding re-

lationships in the benthic and demersal fishes of the Gulf of Alaska and Bering Sea; Marine Birds of Alaska; determination and description of knowledge of the distribution, abundance, and timing of salmonids in the Gulf of Alaska and Bering Sea; Ichthyoplankton of the Eastern Bering Sea; Environmental Assessment of the Southeastern Bering Sea; Zooplankton Micronekton; and trawl survey of the epifaunal invertebrates of Norton Sound, Southeastern Chuckchi Sea, and Kotzebue Sound were studied. GRA

**N79-17367#** National Oceanic and Atmospheric Administration, Boulder, Colo.  
**ENVIRONMENTAL ASSESSMENT OF THE ALASKAN CONTINENTAL SHELF. VOLUME 2: BIOLOGICAL STUDIES** Final Report

Jun. 1978 960 p Sponsored in part by Bureau of Land Management 3 Vol.  
 (PB-289155/4; NOAA-78110702) Avail: NTIS  
 HC A99/MF A01 CSCL 13B

The aquatic fauna and ecology of the Alaskan Continental Shelf which assesses the environmental effects of petroleum developments in that area are reported. Demersal fish and shellfish resources of the Gulf of Alaska from Cape Spencer to Unimak Pass were studied. GRA

**N79-17368#** National Oceanic and Atmospheric Administration, Boulder, Colo.  
**ENVIRONMENTAL ASSESSMENT OF THE ALASKAN CONTINENTAL SHELF. VOLUME 3: BIOLOGICAL STUDIES** Final Report

Jun. 1978 623 p refs Sponsored in part by Bureau of Land Management 3 Vol.  
 (PB-289156/2; NOAA-78110703) Avail: NTIS  
 HC A99/MF A01 CSCL 13B

The aquatic fauna and ecology of the Alaskan Continental Shelf which assess the environmental effects of petroleum developments in that area are reported. Community structure, distribution, and interrelationships of marine birds in the Gulf of Alaska; reconnaissance of the intertidal and shallow subtidal biotic lower Cook inlet; and airborne multispectral mapping of the intertidal zone of Southern Alaska were studied. GRA

**N79-17374#** National Oceanic and Atmospheric Administration, Boulder, Colo.  
**OUTER CONTINENTAL SHELF ENVIRONMENTAL ASSESSMENT PROGRAM.**

**MARINE BIOLOGICAL EFFECTS OF OCS PETROLEUM DEVELOPMENT**

Douglas A. Wolfe Sep. 1978 335 p Sponsored in part by Bureau of Land Manag., Wash., D.C. and EPA, Wash., D.C.  
 (PB-288935/0; NOAA-TM-ERL-OCSEAP-1; NOAA-78102601)  
 Avail: NTIS HC A15/MF A01 CSCL 13B

The proceedings of the first formal scientific review of the Biological Effects Studies managed by NOAA's Outer Continental Shelf Environmental Assessment Program (OCSEAP) were Documented. Bureau of Land Management Environmental Studies Program in support of OCS leasing for Alaskan oil and gas development and NOAA's Energy Resources Project on Fate and Effects of Petroleum Hydrocarbons in Marine Ecosystems and Organisms were studied. Selected topics and a brief synopsis of general comments received from the invited outside reviewers are discussed. GRA

**N79-17378#** Industrial Environmental Research Lab., Research Triangle Park, N. C.

**EPA PROGRAM CONFERENCE REPORT: COAL CLEANING, AN OPTION FOR INCREASED COAL UTILIZATION** Final Report

R. E. Balzhiser, A. W. Deurbauck, S. J. Gage, L. Hoffman, G. A. Issaacs, J. D. Kilgroe, H. Loesch, J. F. McConnell, J. Mullin, J. H. Oxley et al Aug. 1978 149 p refs Conf. held at Arlington, Va., 24-25 May 1977 Prepared in cooperation with Battelle Columbus Labs., Ohio  
 (Grant EPA-R-805374)  
 (PB-288223/1; EPA-600/7-77-130) Avail: NTIS  
 HC A07/MF A01 CSCL 08I



The following topics are discussed: (1) the importance of coal in meeting national energy needs; (2) economics and technology of coal utilization; (3) regional and institutional perspectives; (4) environmental perspectives; (5) coal cleaning applications for SO<sub>2</sub> emission control; (6) engineering/economic analyses of coal preparation with SO<sub>2</sub> cleanup processes for keeping higher sulfur coals in the energy market; (7) the EPA region 4 TVA study; (8) the Homer City experience; and (9) coal cleaning: a vehicle for more effective coal utilization. Panel discussion and concluding remarks are also presented. G.Y.

**N79-17744#** National Bureau of Standards, Washington, D. C. Building Economics and Regulatory Technology Div.

**LIFE-CYCLE COSTING. A GUIDE FOR SELECTING ENERGY CONSERVATION PROJECTS FOR PUBLIC BUILDINGS**

**Final Report**

Rosalie T. Ruegg, John S. McConaughy, G. Thomas Sav, and Kimberly A. Hockenbery Sep. 1978 84 p refs Sponsored in part by DOE

(PB-287804/9; NBS-BSS-113)

Avail: NTIS

HC A05/MF A01 CSCL 05C

A step-by-step guide is presented for using life-cycle costing analysis to evaluate and rank the cost effectiveness of alternative energy conservation retrofit projects to existing public buildings; and to select the most cost-effective design for new buildings. Worksheets, illustrated with a realistic example, and a computer program are provided. This guide is compatible with a life-cycle costing guide prepared for the Department of Energy for use in the Federal Energy Management Program by Federal Agencies and is intended as an aid to state and local governments for use in their energy conservation programs. GRA

**N79-17859#** National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

**COLD-AIR PERFORMANCE OF FREE POWER TURBINE DESIGNED FOR 112-KILOWATT AUTOMOTIVE GAS-TURBINE ENGINE. 2: EFFECTS OF VARIABLE STATOR-VANE-CHORD SETTING ANGLE ON TURBINE PERFORMANCE** Final Report

Kerry L. McLallin and Milton G. Kofskey Feb. 1979 53 p refs

(Contract EC-77-A-31-1011)

(NASA-TM-78993; DOE/NASA/1011-78/28; E-9775) Avail: NTIS HC A04/MF A01 CSCL 21A

The cold-air performance of an axial-flow power turbine with a variable stator designed for a 112-kW automotive gas-turbine engine was determined at speeds from 30 to 110 percent of design and at pressure ratios from 1.11 to 2.67. Performance is presented in terms of equivalent mass flow, torque, power, and efficiency for stator-vane-chord setting angles of 26 degs, 30 degs, 35 degs (design), 40 degs, 45 degs, and 50 degs. Turbine braking performance at a nominal stator setting angle of 107 degs is also presented. Turbine efficiency increased with increasing stator setting angle. A 10-point efficiency increase was obtained by opening the stator from the design setting angle of 35 degs to a setting angle of 45 degs. Author

**N79-17890#** Lockheed Missiles and Space Co., Sunnyvale, Calif.

**THE 25 KW POWER MODULE EVOLUTION STUDY. PART 3: CONCEPTUAL DESIGNS FOR POWER MODULE EVOLUTION. VOLUME 2: PROGRAM PLANS** Final Report

27 Jan. 1979 90 p refs

(Contract NAS8-32928)

(NASA-CR-161146; LMSC-D614944-Pt-3-Vol-2) Avail: NTIS HC A05/MF A01 CSCL 22A

A plan is presented for the evolutionary development and deployment of the power module system with performance capabilities required to support the 1983 to 1990 user requirements. Aspects summarized include program functional, operational, and hardware elements; program work breakdown and specification items; development plans and schedules for developmental and technology milestones; test concepts and timeliness; and ground and orbit operations concepts. A.R.H.

**N79-17896#** Raytheon Co., Wayland, Mass. Equipment Div. **SOLAR POWER SATELLITE (SPS) PILOT BEAM AND COMMUNICATION LINK SUBSYSTEM INVESTIGATION STUDY, PHASE 1 Final Report**

31 Jan. 1979 85 p

(Contract NAS8-33157)

(NASA-CR-161161; ER79-4032)

Avail: NTIS

HC A05/MF A01 CSCL 22B

A preliminary engineering model of ionospheric interactions with the pilot beam was established and used to demonstrate that the dual frequency baseline pilot beam system might not be viable in the presence of an unstable transmission path. Alternate approaches to remove this difficulty are described. Although ionospheric fluctuations will not significantly degrade beam pointing or raise the sidelobe levels, they will reduce transmission efficiency by upwards of 25%. Mitigating strategies to substantially reduce this effect are proposed. Based on the Klystron noise spectrum, the pilot beam transmitter power was determined as a function of frequency offset from the power beam carrier frequency. The RFI from the pilot beam, on the ground and at geosynchronous orbit is shown. Noise levels on the earth's surface due to the SPS are presented as a function of frequency and the number of SPS systems. Analysis of the communication subsystem indicates that a standard telemetry line of 1.544 MB/s would satisfy both voice and data link requirements. Additional links would be required for TV and radio transmissions. A.R.H.

**N79-17897#** National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.

**CHANGES IN THE TERRESTRIAL ATMOSPHERE-IONOSPHERE-MAGNETOSPHERE SYSTEM DUE TO ION PROPULSION FOR SOLAR POWER SATELLITE PLACEMENT**

S. A. Curtis and J. M. Grebowsky Feb. 1979 35 p refs Submitted for publication

(NASA-TM-79719) Avail: NTIS HC A03/MF A01 CSCL 22B

Preliminary estimates of the effects massive Ar(+) injections on the ionosphere-plasmasphere system with specific emphasis on potential communications disruptions are given. The effects stem from direct Ar(+) precipitation into the atmosphere and from Ar(+) beam induced precipitation of MeV radiation belt protons. These injections result from the construction of Solar Power Satellites using earth-based materials in which sections of a satellite must be lifted from low earth to geosynchronous orbit by means of ion propulsion based on the relatively abundant terrestrial atmospheric component, Ar. The total amount of Ar(+) injected in transporting the components for each Solar Power Satellite is comparable to the total ion content of the ionosphere-plasmasphere system while the total energy injected is larger than that of this system. It is suggested that such effects may be largely eliminated by using lunar-based rather than earth-based satellite construction materials. J.M.S.

**N79-17898#** Battelle Columbus Labs., Ohio.

**EARTH ORBITAL ASSESSMENT OF SOLAR ELECTRIC AND SOLAR SAIL PROPULSION SYSTEMS**

R. R. Teeter 30 Sep. 1977 78 p refs

(Contract NASw-2018)

(NASA-CR-158167; BMI-NLVP-TM-77-2)

Avail: NTIS

HC A05/MF A01 CSCL 22B

The earth orbital applications potential of Solar Electric (Ion Drive) and Solar Sail low-thrust propulsion systems are evaluated. Emphasis is placed on mission application in the 1980s. The two low-thrust systems are compared with each other and with two chemical propulsion Shuttle upper stages (the IUS and SSUS) expected to be available in the 1980s. The results indicate limited Earth orbital application potential for the low-thrust systems in the 1980s (primarily due to cost disadvantages). The longer term potential is viewed as more promising. Of the two systems, the Ion Drive exhibits better performance and appears to have better overall application potential. Author

**N79-17984** British Library Lending Div., Boston Spa (England). **ELECTROLYSIS OF ZINC. STATISTICAL MODEL OF THE PROCESS PARAMETERS FOR AN INDUSTRIAL CELL**

A. Deste Oct. 1978 19 p refs Transl. into ENGLISH from

Met. Italiana (Italy), no. 4, 1977 p 133-138  
(BLL-RTS-11317) Avail: British Library Lending Div., Boston Spa, Engl.

The energy balance of an industrial cell for the electrolysis of zinc is examined as a function of the chemical composition of the electrolyte and the physical parameters characterising the process. A factorial experiment was carried out and the following independent variables were considered: electrolyte temperature; time of deposition; current density; electrolyte flow; impurities concentration; organic additives; sulphuric acid; and zinc concentrations. The results of the experiment were computed using a special multiple regression method. The results of the analysis were used for construction of a mathematical model representing a higher degree of approximation of the effects of each of the independent variables and the interaction of selected dependent variables. S.E.S.

**N79-18057\*#** Union Carbide Corp., Tonawanda, N.Y.  
**STUDY OF HYDROGEN RECOVERY SYSTEMS FOR GAS VENTED WHILE REFUELING LIQUID-HYDROGEN FUELED AIRCRAFT**

C. R. Baker Feb. 1979 70 p refs  
(Contract NAS1-14698)  
(NASA-CR-158991) Avail: NTIS HC A04/MF A01 CSCL 21P

Methods of capturing and relieving the cold hydrogen vapor produced during the fueling of aircraft designed to utilize liquid hydrogen fuel were investigated. An assessment of the most practical, economic, and energy efficient of the hydrogen recovery methods is provided. S.E.S.

**N79-18061#** KVB Engineering, Inc., Tustin, Calif.  
**LOW-SULFUR WESTERN COAL USE IN EXISTING SMALL AND INTERMEDIATE SIZE BOILERS Final Report, Feb. 1975 - Feb. 1978**

Kenneth L. Maloney, George L. Moilanen, and P. L. Langsjoen Jul. 1978 444 p.  
(Contract EPA-68-02-1863)  
(PB-287937/7; EPA-600/7-78-153A) Avail: NTIS HC A19/MF A01 CSCL 21D

Western subbituminous coals can be substituted for eastern bituminous coals as an industrial boiler fuel and are compatible with industrial coal-fired units of current design. Two unit types of older design (underfed and traveling grate stokers) experienced difficulty burning western coal. Superiority to eastern coals was demonstrated in terms of SOx, NOx, particulate, and unburned HC emissions. Western coals could be fired at lower excess air and exhibited substantially lower combustible losses than eastern coals. The size of delivered western coal was a problem in most of the stoker-fired units tested: it generally had too large a percentage of fine coal, caused by its poor weathering characteristics. Stoker performance on western coal can be improved by sizing the coal at the point of use, to reduce delivery distances to about 200 miles. GRA

**N79-18287\*#** National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif.  
**TRANSIENT SHUTDOWN ANALYSIS OF LOW-TEMPERATURE THERMAL DIODES**

Richard J. Williams Mar. 1979 21 p refs  
(NASA-TP-1369; A-7642) Avail: NTIS HC A02/MF A01 CSCL 20D

The various thermal diodes available for use in cryogenic systems are described. Two diode types, liquid-trap and liquid-blockage diodes, were considered to be the most attractive, and thermal models were constructed to predict their behavior in the reverse mode. The diodes, which are of similar size and throughput, were also examined experimentally in a parallel test setup under nominally identical conditions. Their characteristics were ascertained in terms of forward-mode and reverse-mode conductances, shutdown times and energies, and recovery to forward-mode operation with ethane as the working fluid in the temperature range 170 K to 220 K. Results show that the liquid-blockage diode is the quicker of the two diodes to shut

down from the forward mode (8 min as opposed to 10 min). However, the liquid-blockage diode has a larger reverse-mode conductance which results in a greater overall evaporator temperature rise. The importance of the relative size and heat inputs to the condenser/reservoir configuration of the liquid-blockage diode and the evaporator trap configuration for the liquid-trap diode are demonstrated. Also included are data which show the susceptibility of the diodes to recovery to forward-mode operation. Guidelines for the choice of a particular diode for an actual application are given. J.M.S.

**N79-18352#** Environmental Protection Agency, Washington, D. C. Vitro Lab. Div.

**ENERGY ENVIRONMENT III**

Oct. 1978 259 p refs Proc. of the 3rd Natl. Conf. on the Interagency Energy/Environment R and D Program, Washington, D. C., 1-2 Jun. 1978 Sponsored by EPA  
(EPA-600/9-78-022) Avail: NTIS HC A12/MF A01

The Interagency Energy/Environment R and D Program unites more than a dozen agencies to ensure that unresolved environmental issues are not a barrier to timely and safe development of national energy resources. To this end, the EPA has invested money each year in the Program since its inception in FY 1975. Substantial progress was made toward achieving the goals. Selected achievements were reviewed at the Third National Conference on the Interagency Energy/Environment R and D Program, convened in Washington, D. C., on June 1 and 2, 1978. These proceedings are a result of the conference. Energy/Environment 3 provides an update of interagency research in particular areas, including health effects, transport processes, ecological effects, mining methods and reclamation, control technology, and integrated technology assessment. This report consists of the addresses, papers, and panel discussions of the conference.

**N79-18353#** Environmental Protection Agency, Research Triangle Park, N.C. Health Effects Research Lab.  
**STATUS OF BIOSCREENING OF EMISSIONS AND EFFLUENTS FROM ENERGY TECHNOLOGIES**

Michael D. Waters and James L. Epler (Oak Ridge National Lab.) In Automation Industries, Inc. Energy/Environment 3 Oct. 1978 p 29-50 refs

Avail: NTIS HC A12/MF A01

Short-term tests with bacteria and yeast mutagenicity assays appear to detect effectively the mutagenic potential of complex environmental or industrial effluents; however, chemical fractionation is necessary to reduce toxicity and concentrate hazardous materials. Extension of the results to higher organisms appears to be valid but needs more testing. The results of the feasibility studies discussed show that biological testing can be carried out with complex organic materials but perhaps only when coupled with the appropriate analytical separation schemes. The primary use that combined chemical and biological work may serve is to aid in isolating and identifying the specific classes or components involved. A number of precautions are listed. G.Y.

**N79-18358#** Environmental Protection Agency, Duluth, Minn. Environmental Research Lab.

**ECOLOGICAL EFFECTS OF COAL-FIRED STEAM-ELECTRIC GENERATING STATIONS**

Gary E. Glass In Automation Industries, Inc. Energy/Environment 3 Oct. 1978 p 121-149 refs

Avail: NTIS HC A12/MF A01

The National Energy Plan recommends an increase of 80% in the use of coal for electricity generation. Such an increase will lead to the construction of many more coal-fired generating facilities. A complete understanding of the effects of such facilities on their surroundings is critical to the agencies responsible for their planning. The research program developed by the Environmental Protection Agency to meet this need is in the third year of a five-year plan. A holistic approach was taken in the design of the program and projects were funded for mining, transportation

and storage, and combustion of coal. Several studies are discussed which deal with these areas and their effects on the environment. G.Y.

**N79-18359#** Environmental Protection Agency, Cincinnati, Ohio. Environmental Research Lab.

**METHODS FOR THE CONTROL OF ENVIRONMENTAL DAMAGE CAUSED BY MINING ENERGY PRODUCING MATERIALS**

Ronald D. Hill, Eugene F. Harris, and S. Jackson Hubbard *In* Automation Industries, Inc. Energy/Environment 3 Oct. 1978 p 165-185 refs

Avail: NTIS HC A12/MF A01

Some of the environmental pollution problems associated with the mining of coal, uranium, and shales (oil) are addressed and the methods for controlling such pollutions are discussed. G.Y.

**N79-18361#** Environmental Protection Agency, Research Triangle Park, N.C. Industrial Environmental Research Lab.

**INTERAGENCY COAL CLEANING TECHNOLOGY DEVELOPMENT**

James D. Kilgroe and Richard E. Hucko (Department of Energy, Pittsburgh) *In* Automation Industries, Inc. Energy/Environment 3 Oct. 1978 p 221-251 refs

Avail: NTIS HC A12/MF A01

Expanding coal production and use is a major goal of the National Energy Policy. A corollary goal is the containment of adverse environment effects from coal use. This paper presents an overview of regulatory activities related to coal cleaning. An analysis of future coal cleaning R and D priorities is presented. A summary of progress on the interagency coal cleaning R and D program is also presented. G.Y.

**N79-18365#** Department of Energy, Washington, D. C. Energy Technology Branch.

**FLUIDIZED-BED COMBUSTION**

Steven I. Freedman *In* Automation Industries, Inc. Energy/Environment 3 Oct. 1978 p 313-321

Avail: NTIS HC A12/MF A01

Many people have become interested in solar energy as a goal for clean, efficient, practical, economic generation of heat and power. A prepackaged, aged, concentrated solar energy is available, coal. Fluidized bed combustion is one of the advanced concepts for the clean combustion of coal. This report discusses operating a fluidized bed steam generator on coal. G.Y.

**N79-18368#** Oklahoma Univ., Norman.

**TECHNOLOGY ASSESSMENT OF WESTERN ENERGY RESOURCE DEVELOPMENT**

Irvin L. White *In* Automation Industries, Inc. Energy/Environment 3 Oct. 1978 p 371-380 refs

Avail: NTIS HC A12/MF A01

An overview is given of the Western Energy Study, the objectives it is intended to achieve, how it is structured and conducted, and the kinds of results it is producing. Water availability was chosen to demonstrate how the problems and issues were identified and defined for policymakers, how this led to additional analysis to identify alternative courses of action, and how these alternatives were analyzed to inform policymakers. The water and dollar cost of energy tradeoffs associated with the choice of cooling options is illustrated. Knowing these tradeoffs, both public and private sector policymakers can make better informed choices. G.Y.

**N79-18373\*#** Geological Survey, Denver, Colo.

**LATE DIAGENETIC INDICATORS OF BURIED OIL AND GAS. 2: DIRECT DETECTION EXPERIMENT AT CEMENT AND GARZA FIELDS, OKLAHOMA AND TEXAS, USING ENHANCED LANDSAT 1 AND 2 IMAGES**

Terrence J. Donovan, Patricia A. Termain, and Mitchell E. Henry, Principal Investigators 1979 49 p refs Sponsored by NASA

Original contains color imagery. Original photography may be purchased from the EROS Data Center, Sioux Falls, S. D. 57198 ERTS

(E79-10099: NASA-CR-158055: Rept-79-243) Avail: NTIS HC A03/MF A01 CSCL 08G

The author has identified the following significant results. The Cement oil field, Oklahoma, was a test site for an experiment designed to evaluate LANDSAT's capability to detect an alteration zone in surface rocks caused by hydrocarbon microseepage. Loss of iron and impregnation of sandstone by carbonate cements and replacement of gypsum by calcite were the major alteration phenomena at Cement. The bedrock alterations were partially masked by unaltered overlying beds, thick soils, and dense natural and cultivated vegetation. Interpreters, biased by detailed ground truth, were able to map the alteration zone subjectively using a magnified, filtered, and sinusoidally stretched LANDSAT composite image; other interpreters, unbiased by ground truth data, could not duplicate that interpretation.

**N79-18424\*#** Michigan State Univ., East Lansing. Remote Sensing Project.

**IDENTIFICATION OF WOOD ENERGY RESOURCES IN CENTRAL MICHIGAN**

William D. Hudson and Kyle Kittleson Nov. 1978 37 p refs (Grant NGL-23-004-083)

(NASA-CR-158130) Avail: NTIS HC A03/MF A01 CSCL 02F

Existing biomass studies were compiled for determining their applicability in measuring forest biomass in an entirely new way. Over sixty tree-weight tables were prepared from existing tables or formulas. An estimate of forest biomass was made on a defined area by using Landsat Satellite data analysis, existing forest cover type maps and actual weighting of the entire biomass. Control plots were cruised for normal volume data and weight data, harvested and weighed to determine actual tonnage yields. S.E.S.

**N79-18439** British Library Lending Div., Boston Spa (England). **THE OPTIMUM VOLTAGE FOR BATTERIES USED IN STANDBY LIGHTING SYSTEMS**

Karel Outlín Dec. 1978 8 p Transl. into ENGLISH from Elektrotechnický obzor (USSR), v. 65, no. 3, 1976 p. 160-162 (BLL-RTS-11512) Avail: British Library Lending Div., Boston Spa, Engl.

Buildings and projects for which the regulations prescribe emergency lighting systems must therefore be equipped with a standby power supply independent of the mains. The source generally used is a system of permanently fixed lead batteries, type J. The initial cost of such a system depends to a large extent on the chosen battery voltage. The relationship between the installation cost and the battery voltage are described. The aim of the paper is to establish the voltage at which these costs are at a minimum. G.Y.

**N79-18442** British Library Lending Div., Boston Spa (England). **THE WORLD BALANCE FOR ENERGY NEEDS IN VIEW OF YEAR 2000: DEVELOPMENT OF THE PROBLEM AND AREAS INVOLVED, PART 2**

J. R. Frisch 9 Oct. 1978 30 p refs Transl. into ENGLISH from Rev. de l'Energ., v. 28, no. 298, Nov. 1977 p 533-548 In ENGLISH and FRENCH

(BLL-Risley-TR-3395-(9091.9F)) Copyright. Avail: British Library Lending Div., Boston Spa, Engl.

Three main conclusions are formed from this detailed analysis: (1) concerns the geographic progression and concentration of consumption; (2) concerns the major role that hydrocarbons will continue to play in maintaining the balance between supply and demand; and (3) brings to light the future contributions of the Third World to the overall formation of requirements. These conclusions are completed by explaining them with reference to a long term view which will enable the year 2000 to be put in perspective at the heart of the historical development of energy. G.Y.

## N79-18443

**N79-18443\*** National Aeronautics and Space Administration. Pasadena Office, Calif.

### **THERMAL ENERGY TRANSFORMER Patent**

C. Martin Berdahl (JPL) and Carl L. Thiele, inventors (to NASA) (JPL) Issued 23 Jan. 1979 5 p Filed 12 Aug. 1977 Supersedes N77-30616 (15 - 21, p 2824) Sponsored by NASA (NASA-Case-NPO-14058-1; US-Patent-4,135,367; US-Patent-Appl-SN-824024; US-Patent-Class-60-641; US-Patent-Class-60-508; US-Patent-Class-60-572; US-Patent-Class-126-271; US-Patent-Class-165-105) Avail: US Patent and Trademark Office CSCL 10A

For use in combination with a heat engine, a thermal energy transformer is presented. It is comprised of a flux receiver having a first wall defining therein a radiation absorption cavity for converting solar flux to thermal energy, and a second wall defining an energy transfer wall for the heat engine. There is a heat pipe chamber interposed between the first and second walls having a working fluid disposed within the chamber and a wick lining the chamber for conducting the working fluid from the second wall to the first wall. Thermal energy is transferred from the radiation absorption cavity to the heat engine.

Official Gazette of the U.S. Patent and Trademark Office

**N79-18445\*** National Aeronautics and Space Administration. Pasadena Office, Calif.

### **AN IMPROVED SOLAR PANEL AND METHOD FOR FABRICATING THE SAME Patent Application**

Joseph Bonacquisti (RCA Corp., Princeton, New Jersey) and Marvin S. Crouthanel, inventors (to NASA) (RCA Corp., Princeton, New Jersey) Filed 6 Mar. 1979 19 p Sponsored by NASA (Contract JPL-954352) (NASA-Case-NPO-14490-1; US-Patent-Appl-SN-017884) Avail: NTIS HC A02/MF A01 CSCL 10A

A method for the fabrication of solar panels and in particular laminated solar panels is presented. The method has steps which are particularly adaptable for automation. The solar panel is fabricated by electrically interconnecting a plurality of individual solar cells into a plurality of strings and connecting the plurality of strings into an array. The array is laminated between a pair of transparent plates. NASA

**N79-18447\*** Oak Ridge National Lab., Tenn. Regional and Urban Studies Section.

### **BUILDINGS ENERGY USE DATA BOOK, EDITION 1**

G. E. Liepins, M. A. Smith, A. B. Rose, and K. Haygood Apr. 1978 486 p refs (Contract W-7405-eng-26) (ORNL-5363) Avail: NTIS HC A21/MF A01

The initial effort is reported of Oak Ridge National Laboratory to develop the document Buildings Energy Use Data Book for use as a desk-top reference for conservation and solar applications, conservation planning and policy. An assembly and display of statistics which characterize current and past energy end use activities in the residential/commercial sector are presented along with data on other factors which influence the residential/commercial sector in the nation. Statistical data on energy use in the residential/commercial sector in the form of tables, graphs, and charts are presented. A large amount of relevant data in an easily retrievable and usable format is presented. The following topics are covered: sector definitions, buildings inventory, appliance inventory, heating and cooling units inventory, appliance efficiencies, structural characteristics, climatological and appliance fuel use, national economic and demographic determinants, fuel consumption and prices, and a survey of selected energy studies. A list of data sources is provided at the end of topic. F.O.S.

**N79-18448\*** IBM Federal Systems Div., Huntsville, Ala. **SYSTEM INTEGRATION OF MARKETABLE SUBSYSTEMS Progress Reports**

Feb. 1979 61 p Prepared for DOE (Contract NAS8-32036) (NASA-CR-161104) Avail: NTIS HC A04/MF A01 CSCL 10B

Progress is reported in the following areas: systems integration of marketable subsystems; development, design, and building of

site data acquisition subsystems; development and operation of the central data processing system; operation of the MSFC Solar Test Facility; and systems analysis. J.M.S.

**N79-18449\*** Wyle Labs., Inc., Huntsville, Ala. Solar Energy Systems Div.

### **THERMAL PERFORMANCE EVALUATION OF MSFC HOT AIR COLLECTORS WITH VARIOUS FLOW CHANNEL DEPTH**

Jan. 1979 19 p refs Prepared for DOE (Contract NAS8-32036) (NASA-CR-150900) Avail: NTIS HC A02/MF A01 CSCL 10B

The test procedures used and the results obtained during the evaluation test program on the MSFC air collector with flow channel depth of 3 in., 2 in., and 1 in., under simulated conditions are presented. The MSFC hot air collector consists of a single glass cover with a nonselective coating absorber plate and uses air as the heat transfer medium. The absorber panel consists of a thin flat sheet of aluminum. J.M.S.

**N79-18450\*** Wyle Labs., Inc., Huntsville, Ala. Solar Energy Systems Div.

### **LONG-TERM WEATHERING EFFECTS ON THE THERMAL PERFORMANCE OF THE LIBBEY-OWENS-FORD (LIQUID) SOLAR COLLECTOR**

Jan. 1979 13 p refs Prepared for NASA and DOE (Contract NAS8-32036) (NASA-CR-161093) Avail: NTIS HC A02/MF A01 CSCL 10A

Thermal performance tests were conducted on the Libbey-Owens-Ford liquid collector, following long term exposure to natural weathering conditions. Visual inspection of the collector, prior to the retest, indicated noticeable clouding of the inner cover glass, probably resulting from outgassing of the insulation. The absorber plate also showed some discoloration. The test results indicated that performance degradation had occurred at inlet temperatures significantly above ambient. The change in the slope of the efficiency curve, from the original data, is a direct indicator of an increase in the collector heat loss coefficient. J.M.S.

**N79-18451\*** Motorola, Inc., Phoenix, Ariz. Semiconductor Group.

### **PHASE 1 OF THE AUTOMATED ARRAY ASSEMBLY TASK OF THE LOW COST SILICON SOLAR ARRAY PROJECT Final Report**

R. A. Pryor, L. A. Grenon, and M. G. Coleman Jan. 1978 300 p refs Prepared for JPL and DOE (Contracts NAS7-100; JPL-954363) (NASA-CR-158120; Rept-2258/8; DOE/JPL-954363-78/8) Avail: NTIS HC A13/MF A01 CSCL 10A

The results of a study of process variables and solar cell variables are presented. Interactions between variables and their effects upon control ranges of the variables are identified. The results of a cost analysis for manufacturing solar cells are discussed. The cost analysis includes a sensitivity analysis of a number of cost factors. S.E.S.

**N79-18453\*** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena. **BLOCK 4 SOLAR CELL MODULE DESIGN AND TEST SPECIFICATION FOR RESIDENTIAL APPLICATIONS Low-Cost Solar Array Project**

1 Nov. 1978 31 p refs Sponsored by NASA and DOE (NASA-CR-158117; JPL-5101-83; DOE/JPL-1012-78/14) Avail: NTIS HC A03/MF A01 CSCL 10A

Near-term design, qualification and acceptance requirements are provided for terrestrial solar cell modules suitable for incorporation in photovoltaic power sources (2 kW to 10 kW) applied to single family residential installations. Requirement levels and recommended design limits for selected performance criteria are specified for modules intended principally for rooftop installations. Modules satisfying the requirements of this specification fall into one of two categories, residential panel or residential shingle, both meeting general performance requirements plus additional category peculiar constraints. L.S.

**N79-18454\*** Solar Engineering and Equipment Co., Metairie, La.

**INSTALLATION PACKAGE FOR A SOLAR HEATING SYSTEM**

Dec. 1978 70 p Prepared for DOE  
(Contract NAS8-32247)  
(NASA-CR-150876) Avail: NTIS HC A04/MF A01 CSCL 10A

Installation information is given for a solar heating system installed in Concho Indian School at El Reno, Oklahoma. This package includes a system Operation and Maintenance Manual, hardware brochures, schematics, system operating modes and drawings. L.S.

**N79-18456\*** Stuttgart Univ. (West Germany). Forschungsinst. Windenergie-technik.

**EXPERT OPINION ON WIND ENERGY CONVERSION SYSTEMS DESIGNED BY HERMANN HONNEF Final Report**

Heiner Doerner Dec. 1977 80 p refs In GERMAN; ENGLISH summary Sponsored by Bundesmin. fuer Forsch. u. Technol. (BMFT-FB-T-77-35) Avail: NTIS HC A05/MF A01; ZLDI, Munich DM 16,80

The plans by Hermann Honnef for using wind power by means of large-scale wind energy conversion systems with regard to the proposed technical design and their presently expected cost-effectiveness were assessed. The conclusion that the findings and experience of the past few decades have shown that this type of wind energy conversion systems using contra-rotating, multi-blade turbines are not economical. The cost-effectiveness of this type was compared unfavorably with the advanced type of free-running, two-bladed turbines. The assertion that wind conditions at altitudes between 200 and 500 m were sufficiently explored for the purpose of wind energy facilities, is not valid. S.E.S.

**N79-18457\*** Brown, Boveri und Cie, A.G., Heidelberg (West Germany). Zentrales Forschungslab.

**SOLAR WATER HEATING Final Report**

Hermann Birnbreier, Juergen Broschke, Bernd Dietrich, Rudolf Gehr, Peter Goericks, Uwe Heidtmann, Wolfgang Kimpenhaus, Karl Liemert, Gerhard Riebold, Karl Sueser et al Dec. 1977 101 p refs In GERMAN; ENGLISH summary Sponsored by Bundesmin. fuer Forsch. u. Technol. Prepared jointly with Sueddeut. Metallwerke GmbH and Rheinisch Westfael. Elektrizitaetswerke AG (BMFT-FB-T-77-42) Avail: NTIS HC A06/MF A01; ZLDI, Munich DM 21,20

Tap water heating with conventional oil heating plants is performed with very low efficiency in summertime (5-20%). The object of this project was to evaluate if, in this season, solar energy can be used in middle Europe for water heating. Investigations were made on the stationary and daily efficiency of solar collectors alone as well as on complete solar systems at different places. The results show that about 50 to 90% of the heat requirement can be gained from solar energy, depending on the size of the collector area and water consumption. Due to unsteady weather conditions a supplementary electric heater is needed in the summer as well. The average annual useful heat gain per square meter area is about 1 kWh per day. G.Y.

**N79-18460\*** Bundesministerium fuer Wissenschaft und Forschung, Vienna (Austria).

**AUSTRIAN 10kWE SOLAR POWER PLANT. A PROJECT OF THE FEDERAL MINISTRY FOR SCIENCE AND RESEARCH**

Federal Press Serv. 1977 28 p  
Avail: NTIS HC A03/MF A01

Concepts under development in other nations were surveyed to clarify available options in the design and construction of a small solar energy plant suitable for use in developing countries. The possibility of marketing an Austrian-made power plant capable of operating without an human service was assessed as well as the possibility of supplying single components to users. Aspects of the design under consideration discussed include collector

circuits, freon circuits, prime movers, generator and electric networks, plant performance, and thermal storage. A.R.H.

**N79-18461\*** Austrian Solar and Space Agency, Vienna.  
**PROPOSAL FOR A REPRESENTATION OF THE QUASI-STEADY-STATE PERFORMANCE OF FLAT-PLATE COLLECTORS**

H. Koch (Univ. of Technol., Vienna) and M. Bruck Dec. 1977 17 p refs  
(ASSA-SE-B21/77) Avail: NTIS HC A02/MF A01

For reasons of simplicity and clearness the calculations and reflections of this proposal are confined to flat-plate collectors with a liquid heat transfer fluid with or without glass cover. Most of the well-known proposals represent the so-called efficiency of a collector (i.e. the ratio of insulation to useful heat extracted) virtually as a function of the difference between mean collector temperature and ambient air temperature. Errors of accuracy occur with this method the higher the average collector temperature is chosen. In this proposal, low temperature collectors (i.e. collectors without thermal insulation operated in combination with heat pumps within the range of ambient air temperature) are considered. The proposal, therefore, attempts to plot the efficiency of a collector which largely avoids certain disadvantages and inaccuracies of high temperature collectors. G.Y.

**N79-18462\*** Woodard-Clyde Consultants, San Francisco, Calif.  
**IMPACT PREDICTION MANUAL FOR GEOTHERMAL DEVELOPMENT**

Jun. 1978 163 p refs  
(Contract DI-14-16-0008-2132)  
(PB-288128/2; FWS/OBS-78/77; LC-78-600108) Avail: NTIS HC A08/MF A01 CSCL 10A

Techniques for predicting probable effects of geothermal development on fish and wildlife resources in the Western United States are described. Appendices include an annotated bibliography; an example of a data collection program; a listing of endangered, threatened, and protected flora and fauna; and a supplement to erosion analysis techniques outlined in the manual. GRA

**N79-18463\*** Illinois Univ., Urbana-Champaign. Water Resources Center.

**RESOURCE ANALYSIS: WATER AND ENERGY AS LINKED RESOURCES Final Report**

Margaret Lounsbury, Sanore Hebenstreit, and R. Stephen Berry Aug. 1978 210 p refs Prepared in cooperation with Chicago Univ., Ill.  
(Contract DI-14-31-0001-7030; OWRT Proj. A-081-ILL)  
(PB-288046/6; UIIU-WRC-78-0134; W79-00453; OWRT-A-081-ILL(1); RR-134) Avail: NTIS HC A10/MF A01 CSCL 10A

An evaluation is made of the energy required to supply and treat water, rather than the water requirements of energy production. The primary energy requirements for three sectors of water management--municipal water supply, municipal sewage treatment, and water for irrigation--are evaluated. Six major cities, Chicago, Denver, Los Angeles, New Orleans, San Antonio, and St. Louis, are used as indicators of the national trend in energy requirements to supply water to municipalities. Nationwide data provided by the federal Environmental Protection Agency for 1977 and 1990 are used to determine the rate of change of energy required to treat municipal sewage over this period. The energy required to supply water for irrigation is estimated for three regions in the Southwest: Kern County, California; the Texas high plains; and San Carlos, Arizona. GRA

**N79-18464\*** Environmental Protection Agency, Washington, D. C. Office of Energy, Minerals and Industry.

**PUBLIC HEARING TRANSCRIPT: FEDERAL NON-NUCLEAR ENERGY RESEARCH AND DEVELOPMENT PROGRAM**

Steve Plotkin and Jim Stemmler Jul. 1978 477 p refs  
(PB-287910/4; EPA-600/9-78-023) Avail: NTIS HC A21/MF A01 CSCL 10A

The proceedings of three days of public hearings on the Federal Nonnuclear Energy Research and Development Program

are presented. Future energy patterns and levels of coal use, solar energy and conservation, and oil shale and synthetic fuels from coal are among the topics discussed. GRA

**N79-18465#** National Technical Information Service, Springfield, Va.

**OPTICAL COATINGS FOR SOLAR CELLS AND SOLAR COLLECTORS. CITATIONS FROM THE NTIS DATA BASE Progress Report, 1964 - Oct. 1978**

Brian Carrigan Dec. 1978 248 p Supersedes NTIS/PS-77/1036; NTIS/PS-76/0855; NTIS/PS-75/692; NTIS/PS-75/137 2 Vol.

(NTIS/PS-78/1341/3; NTIS/PS-77/1036; NTIS/PS-76/0855; NTIS/PS-75/692; NTIS/PS-75/137) Avail: NTIS HC \$28.00/MF \$28.00 CSCL 10A

Materials and research for the development of selective coatings for solar energy conversion devices are described in these citations. These materials include types of coatings or covers used to reflect or transmit solar radiation in order to optimize solar conversion to heat or electricity. Most studies concern antireflection, thermal control, or reflective coatings. Coatings which act as optical filters are also covered. This updated bibliography contains 241 abstracts, 41 of which are new entries to the previous edition. GRA

**N79-18466#** National Technical Information Service, Springfield, Va.

**OPTICAL COATINGS FOR SOLAR CELLS AND SOLAR COLLECTORS. CITATIONS FROM THE ENGINEERING INDEX DATA BASE Progress Report, 1970 - Dec. 1978**

Brian Carrigan Dec. 1978 175 p 2 Vol. (NTIS/PS-78/1342/1) Avail: NTIS HC \$28.00/MF \$28.00 CSCL 10A

This bibliography of worldwide journal literature cites 169 reports on materials and research for the development of selective coatings for solar energy conversion devices. These materials include types of coatings or covers used to reflect or transmit solar radiation in order to optimize solar conversion to heat or electricity. Most studies concern anti-reflection, thermal control, or reflective coatings. Coatings which act as optical filters are also covered. GRA

**N79-18487#** TRW, Inc., Redondo Beach, Calif. Environmental Engineering Div.

**ENVIRONMENTAL ASSESSMENT DATA BASE FOR HIGH-Btu GASIFICATION TECHNOLOGY. VOLUME 1: TECHNICAL DISCUSSION Final Report, Jun. 1977 - Aug. 1978**

M. Ghassemi, K. Crawford, and S. Quinlivan Sep. 1978 172 p refs 3 Vol.

(Contract EPA-68-02-2635) (PB-288602/6; EPA-600/7-78-186A) Avail: NTIS HC A08/MF A01; also available in set of 3 reports HC E13 as PB-288601-SET CSCL 07A

The existing data base for the EA of treated effluent of this quality is acceptable for discharge under the San Leandro Municipal Discharge Limitations with the exception of the phenolic compound and total cyanide loadings is analyzed and summarized. Surcharges would be imposed, however, based on the suspended solids and BOD loadings. If significant levels of phenolic compounds and cyanide are not present in a particular plant's wastewater discharge, ultrafiltration is judged capable of meeting local Municipal Discharge Standards. When phenolic compounds and cyanide are present at significant levels either ozonation or reverse osmosis are considered the preferred post-treatment processes. None of the treatment system options investigated is considered capable of reducing adhesives and sealants manufacturing plant wastewater BOD and COD loadings to the recommended Effluent Limitations Guidelines. GRA

**N79-18488#** TRW, Inc., Redondo Beach, Calif. Environmental Engineering Div.

**ENVIRONMENTAL ASSESSMENT DATA BASE FOR HIGH-Btu GASIFICATION TECHNOLOGY. VOLUME 2: APPENDICES A, B, AND C Final Report, Jun. 1977 - Aug. 1978**

M. Ghassemi, K. Crawford, and S. Quinlivan Sep. 1978 415 p refs 3 Vol.

(Contract EPA-68-02-2635) (PB-288603/4; EPA-600/7-78-186B) Avail: NTIS HC A18/MF A01; also Available in set of 3 reports HC E13 as PB288601-SET CSCL 07A

The existing data base for the EA of technology is reported and limitations of available data are identified. Results of the data base analysis indicate that there currently are insufficient data for comprehensive EA. The data are limited since: (1) there are no integrated plants, (2) some of the pilot plant data are not applicable to commercial operations, (3) available pilot plant data are generally not very comprehensive in that not all streams and constituents/parameters of environmental interest are addressed, (4) there is a lack of experience with control processes/equipment in high-Btu gasification service, and (5) toxicological and ecological implications of constituents in high-Btu gasification waste streams are not established. GRA

**N79-18489#** TRW, Inc., Redondo Beach, Calif. Environmental Engineering Div.

**ENVIRONMENTAL ASSESSMENT DATA BASE FOR HIGH-Btu GASIFICATION TECHNOLOGY. VOLUME 3: APPENDICES D, E, AND F Final Report, Jun. 1977 - Aug. 1978**

M. Ghassemi, K. Crawford, and S. Quinlivan Sep. 1978 342 p refs 3 Vol.

(Contract EPA-68-02-2635) (PB-288604/2; EPA-600/7-78-186C) Avail: NTIS HC A15/MF A01; also available in set of 3 reports HC E13 as PB-288601-SET CSCL 07A

The existing data base for the EA of technology is reported and limitations of available data are identified. Results of the data base analysis indicate that there currently are insufficient data for comprehensive EA. A number of programs are currently under way or planned which should generate some of the needed data. GRA

**N79-18497#** Kerr (Robert S.) Environmental Research Lab., Ada, Okla.

**TREATMENT OF PETROLEUM REFINERY, PETROCHEMICAL AND COMBINED INDUSTRIAL-MUNICIPAL WASTE: WATERS WITH ACTIVATED CARBON: LITERATURE REVIEW**

John E. Matthews Sep. 1978 98 p refs (PB-288211/6; EPA-600/2-78-200) Avail: NTIS HC A05/MF A01 CSCL 13B

A review of the literature on activated carbon adsorption as a treatment concept for petroleum refinery, petrochemical plant, and combined industrial-municipal wastewaters is presented in this report. A total of 241 references are cited. These references cover the various aspects of carbon adsorption and its application in the treatment of industrial and municipal wastewaters. GRA

**N79-18535** Northwestern Univ., Evanston, Ill. **STOCHASTIC ANALYSIS OF WIND CHARACTERISTICS FOR ENERGY CONVERSION Ph.D. Thesis**

Arden Burdet Sigl 1978 134 p Avail: Univ. Microfilms Order No. 7903363

Persistence and correlation analyses are carried out on 19 digital velocity records ranging in length from 4 to 24 years. Of these 19 records, 17 were obtained from the National Climatic Center and 2 from Argonne National Laboratory. These records are analyzed by season using random data analysis procedures to develop mathematical models that aid in assessing the wind potential of proposed wind energy conversion system (WECS) sites. From the analysis of the cross-correlation results it is feasible to employ statistics at a site for which long term records are available to assess the representativeness of the short term record monitored at the WECS site. When applying this approach, judgement must be used in a region which has significant topographical features which affect the flow of air over the region. Dissert. Abstr.

**N79-18758#** Technische Hogeschool, Eindhoven (Netherlands). Group Direct Energy Conversion.

**EXPERIMENTAL INVESTIGATION ON THE DISCHARGE STRUCTURE IN A NOBLE GAS MHD GENERATOR**

C. A. Borghi, A. F. C. Sens, A. Veeffkind, and L. H. T. Rietjens  
Jan. 1978 22 p refs Sponsored partly by Bologna Univ. and  
partly by CNR  
(TH-78-E-79; ISBN-90-6144-079-3) Avail: NTIS  
HC A02/MF A01

An experimental investigation of the discharge structure in a noble gas MHD plasma has been performed, employing streak photography and other optical diagnostics. The discharge appeared to be concentrated in streamers. It was observed that the streamer structure of the discharge is very pronounced at stagnation temperatures around 2000 K, where the conductivity of the plasma becomes critical. Moreover, the observations indicate the presence of friction forces which result in a velocity of the streamers being always close to the velocity of the gas flow. The observations suggest that streamers are generated by break down phenomena at the inlet of the generator and subsequently convected downstream the channel. The structure of the discharge in the direction perpendicular to the electrode walls was analyzed by taking streak pictures with the slit in this direction in order to obtain information about the angle of propagation of the streamers.

Author

**N79-18810** Committee on Science and Technology (U. S. House).  
**ELECTRIC AND HYBRID VEHICLE ACT, PUBLIC LAW  
94-413 DEMONSTRATION PROGRAM OBJECTIVE AND  
SCHEDULE**

Washington GPO 1978 428 p refs Hearing before the  
Subcomm. on Advanced Energy Technologies and Energy  
Conservation Res., Development and Demonstration of the Comm.  
on Sci. and Technol., 95th Congr., 1st Sess., No. 41, 12 Jul.  
1977

(GPO-98-809) Avail: Subcomm. on Advanced Energy  
Technologies and Energy Conservation Res., Development and  
Demonstration

The status of implementation of an act authorizing the research, development, and demonstration of electric and hybrid electric vehicles is assessed. Opportunities and risks associated with various implementation strategies available to ERDA are identified and analyzed with respect to their potential for achieving expressed goals. The motivating policies are long-term petroleum savings, urban environment relief, and development of a competitive U.S. electric and hybrid vehicle industry. Topics discussed include energy storage systems, technology transfer, financial incentives, vehicle demonstration, vehicle service and other infrastructure requirements, safety considerations and requirements, and major factors influencing industry development.

A.R.H.

**N79-18815\*** National Aeronautics and Space Administration.  
Goddard Space Flight Center, Greenbelt, Md.

**BALTIMORE APPLICATIONS PROJECT Annual Progress  
Report. Jun. 1977 - May 1978**

Thomas S. Golden and Philip Yaffee Jun. 1978 18 p  
(NASA-TM-79667; APR-4) Avail: NTIS HC A02/MF A01 CSCL  
05A

The Baltimore Applications Project (BAP) was originally designed as an experimental effort to assist the government of the City of Baltimore in applying technology to the solution of municipal problems. Recent modifications in the structuring and operation of the program are discussed. A tabular update on the individual tasks undertaken and their treatment is provided. Details of energy and nonenergy related tasks are presented in appendices.

J.M.S.

**N79-18817** Department of Energy, Washington, D. C.  
Transportation Energy Conservation Div.

**CHARACTERIZATION STUDY OF AN ELECTRIC MOTOR-  
TRANSMISSION SYSTEM FOR ELECTRIC VEHICLES**

Mar. 1978 108 p refs  
(Contract EY-76-C-02-2835)

(HCP/M-2835/01) Avail: NTIS HC A06/MF A01

A unique electric transmission concept, consisting of two DC traction motors in tandem, for use in automotive vehicles is described. The device does away with the requirement of intermittent current supply at low speeds, and is shown to be

superior to conventional electric motor drives with regard to efficiency, flexibility of torque-speed requirements, control, and adaptability to regenerative braking. The electric motor-transmission can operate in either the differential, single-motor, or additive mode, producing both forward and reverse speeds while covering the entire spectrum of torque, speed, and power required by an automotive vehicle. A detailed study of a 7.5 Kw model was performed, providing performance data, current drain, output, efficiencies, and other relevant system characteristics. Based on this data, a preliminary design is formulated including estimates of size, weight, and cost. A catalog of specifications for power ratings ranging from 3.7 Kw to 15 Kw is included, so that the automotive designer may select a unit most appropriate to his vehicle.

L.S.

**N79-18834#** Water Purification Associates, Cambridge, Mass.  
**WATER-RELATED ENVIRONMENTAL EFFECTS IN FUEL  
CONVERSION, VOLUME 1. SUMMARY Final Report, Oct.  
1976 - Sep. 1978**

Harris Gold and David J. Goldstein Oct. 1978 247 p  
(Contract EPA-68-03-2207; DOE-EX-76-C-01-2445)  
(PB-288313/0; EPA-600/7-78-197A) Avail: NTIS  
HC A11/MF A01 CSCL 07A

Results of an examination of water-related effects that can be expected from siting conversion plants in the major U.S. coal and oil shale bearing regions are presented. Ninety plant-site combinations were studied: 48 in the Central and Eastern U.S. and 42 in the Western. Synthetic fuel technologies examined include: coal gasification to convert coal to pipeline gas; coal liquefaction to convert coal to low sulfur fuel oil; coal refining to produce a de-ashed, low-sulfur solvent refined (clean) coal; and oil shale retorting to produce synthetic crude. Results presented include the range of water requirements, conditions for narrowing the range and optimizing the use of water, ranges of residual solid wastes, and cost and energy requirements for waste water treatment.

J.M.S.

**N79-18969#** Dynamics Research Corp., Wilmington, Mass.  
Systems Div.

**AN ANALYSIS OF FUEL CONSERVING OPERATIONAL  
PROCEDURES AND DESIGN MODIFICATIONS FOR  
BOMBER/TRANSPORT AIRCRAFT. VOLUME 1: EXECU-  
TIVE SUMMARY Final Report, 7 Jun. 1976 - 7 Jul. 1978**

R. Aggarwal Jul. 1978 24 p refs  
(Contract F33615-76-C-3104)  
(AD-A061746; R-247U-Vol-1; AFFDL-TR-78-96-Vol-1) Avail:  
NTIS HC A02/MF A01 CSCL 01/3

Various proposed improvements in the design and operational procedures for bomber/transport aircraft are evaluated. The evaluation is performed in terms of the estimated savings in fuel consumption and in Direct Operating Cost (DOC). As an aid in the evaluation of design modifications, graphs of fuel and DOC savings as a function of the design parameters are developed. These graphs are based on actual mission trajectory data rather than some type trajectory profile. The actual mission data is presented in terms of histograms which provide statistical information concerning altitude, air speed, take-off weight, landing weights, and mission time. Separate analyses are performed on the following aircraft: the B-52G, the B-52H, the KC-135, the C-141, the C-130, and the C-5A.

Author (GRA)

**N79-19069\*** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.  
**THE UPDATED ALGORITHM OF THE ENERGY CONSUMP-  
TION PROGRAM (ECP): A COMPUTER MODEL SIMULA-  
TING HEATING AND COOLING ENERGY LOADS IN  
BUILDINGS**

F. L. Lansing, D. M. Strain, V. W. Chai, and S. Higgins In *its*  
*The Deep Space Network* 15 Feb. 1979 p 107-115

Avail: NTIS HC A09/MF A01 CSCL 10B

The energy Consumption Computer Program was developed to simulate building heating and cooling loads and compute thermal and electric energy consumption and cost. This article reports on the new additional algorithms and modifications made in an effort to widen the areas of application. The program

structure was rewritten accordingly to refine and advance the building model and to further reduce the processing time and cost. The program is noted for its very low cost and ease of use compared to other available codes. The accuracy of computations is not sacrificed however, since the results are expected to lie within + or - 10% of actual energy meter readings. Author

**N79-19060\*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena. A TWO-DIMENSIONAL THERMAL ANALYSIS OF A NEW HIGH-PERFORMANCE TUBULAR SOLAR COLLECTOR**

F. L. Lansing and C. S. Yung *In its The Deep Space Network* 15 Feb. 1979 p 116-131 refs

Avail: NTIS HC A09/MF A01 CSCL 10A

The first of two articles are presented which describe and analyze the thermal performance of a vacuum tube solar collector. The assumptions and mathematical modeling are presented. The problem is reduced to the formulation of two simultaneous linear differential equations characterizing the collector thermal behavior. After applying the boundary conditions, a general solution is obtained which is found similar to the general Hottel, Whillier and Bliss form but with a complex flow factor. L.S.

**N79-19071\*# Rockwell International Corp., Downey, Calif. Satellite Systems Div.**

**SATELLITE POWER SYSTEM (SPS) CONCEPT DEFINITION STUDY (EXHIBIT C) Final Review**

G. M. Haley 21 Mar. 1979 477 p refs

(Contract NAS8-32475)

(NASA-CR-161173; SSD-79-0076)

Avail: NTIS

HC A21/MF A01 CSCL 22B

The major outputs of the study are the constructability studies which resulted in the definition of the concepts for satellite, rectenna, and satellite construction base construction. Transportation analyses resulted in definition of heavy-lift launch vehicle, electric orbit transfer vehicle, personnel orbit transfer vehicle, and intra-orbit transfer vehicle as well as overall operations related to transportation systems. The experiment/verification program definition resulted in the definition of elements for the Ground-Based Experimental Research and Key Technology plans. These studies also resulted in conceptual approaches for early space technology verification. The cost analysis defined the overall program and cost data for all program elements and phases. G.Y.

**N79-19169 Oklahoma State Univ., Stillwater.**

**CATALYST AGING TESTS AND THE ROLE OF CATALYST WETTING ON HYDRODESULFURIZATION OF A COAL DERIVED LIQUID Ph.D. Thesis**

Dhirendra Chhotatal Mehta 1978 253 p

Avail: Univ. Microfilms Order No. 7903708

A trickle bed reactor was selected to study the hydrodesulfurization of raw anthracene oil, a coal derived oil, over various commercially available Co-Mo-Alumina catalysts. The experimental equipment was designed for operating conditions ranging from ambient to 850 F (455 C) and 1,800 psig pressure. The hydrodesulfurization studies were conducted at reactor temperatures of 600,650,700 and 750 F (314,343,371 and 399 C), at pressure of 500,1,000 and 1,500 psig and at liquid volume hourly space times ranging from 0.325 to 1.480 hours. The hydrotreating catalysts were also tested for their aging characteristics during 200-hour runs at steady reactor conditions of 700 F (371 C), 1,000 psig and 0.44 liquid weight hourly space time. Constant amounts of catalyst, 20 grams, were used for all the experimental runs. Various kinetic models were tested for their relative fit to the results of the study. Dissert. Abstr.

**N79-19171# Westinghouse Electric Corp., Pittsburgh, Pa. Advanced Energy Systems Div.**

**METHANE UTILIZATION FROM COALBEDS FOR POWER GENERATION Quarterly Technical Progress Report, 1 Dec. 1977 - 1 Apr. 1978**

1 Apr. 1978 12 p

(Contract EY-77-C-21-8098)

(TID-28408) Avail: NTIS HC A02/MF A01

Technical progress is reported in engineering a system to demonstrate the economic utilization of mine gas (a diluted mixture of methane and air) as a fuel for gas turbine/electrical generator conversion of mine gas to electrical energy. Aspects reviewed include modification of the Saturn engine to use gaseous fuel, design of skid mounted interface equipment, the use of existing gob degasification boreholes as a fuel source, fuel analysis, safety review, electrical power interface, environmental impact, economic analysis, and fuel reservoir characteristics. A.R.H.

**N79-19173# TRW Systems, Redondo Beach, Calif.**

**APPLICABILITY OF PETROLEUM REFINERY CONTROL TECHNOLOGIES TO COAL CONVERSION Final Report, Jul. 1977 - Aug. 1978**

M. Ghassemi, D. Strehler, K. Crawford, and S. Quinlivan Oct. 1978 127 p refs

(Contract EPA-68-02-2635)

(PB-288630/7; EPA-600/7-78-190)

Avail: NTIS

HC A07/MF A01 CSCL 07A

This is part of a comprehensive program for the environmental assessment of high-Btu gasification technology. Process/waste streams from coal gasification and liquefaction processes were characterized. Streams with refinery counterparts were identified. Toxicological and health effects data were also collected on waste stream constituents. Control technologies used in refineries to manage the identified streams were evaluated and their applicability to counterpart coal conversion streams was assessed. Study results indicate that, despite similarities between the refinery process/waste streams and their coal conversion counterparts, significant composition differences between the analogous streams would affect applicability and design of a control technology. GRA

**N79-19186\* National Aeronautics and Space Administration. Pasadena Office, Calif.**

**ELECTROMAGNETIC RADIATION ENERGY ARRANGEMENT Patent**

Robert R. Lipkis (Thompson, Ramo Wooldridge, Inc., Cleveland) and John E. Vehrencamp, inventors (to NASA) (Thompson Ramo Wooldridge, Inc., Cleveland) Issued 16 Mar. 1965 4 p Filed 26 May 1961 Sponsored by NASA

(NASA-Case-WOO-00428-1; US-Patent-3,173,801;

US-Patent-Appl-SN-112999; US-Patent-Class-117-35) Avail: US Patent and Trademark Office CSCL 20N

A solar energy collector and infrared energy reflector is described which comprises a vacuum deposited layer of aluminum of approximately 200 to 400 Angstroms thick on one side of a substrate. An adherent layer of titanium with a thickness of between 800 and 1000 Angstroms is vacuum deposited on the aluminum substrate and is substantially opaque to solar energy and substantially transparent to infrared energy.

Official Gazette of the U.S. Patent and Trademark Office

**N79-19305# Air Force Academy, Colo.**

**THE DEVELOPMENT OF A LASER DOPPLER VELOCIMETRY SYSTEM FOR UNSTEADY SEPARATED FLOW RESEARCH: PRELIMINARY RESULTS Interim Report, Sep. 1977 - Sep. 1978**

R. A. Kadlec, G. W. Sparks, Jr., and Michael S. Francis Oct. 1978 28 p refs

(AF Proj. 2307)

(AD-A061724; FJSRL-TR-78-0010)

Avail: NTIS

HC A03/MF A01 CSCL 20/4

Each of the six case studies documents public participation in Federal and/or state governmental decisions related to energy facility siting. Four of the cases involved decisions on specific facilities at specific sites, namely: (1) various state and federal licensing procedures for the Seabrook, New Hampshire nuclear facility; (2) the Maine Environmental Improvement Commission's denial of a permit for an oil refinery on Sears Island in Penobscot Bay; (3) the Atomic Energy Commission's amendment to the license for the Big Rock Point, Michigan nuclear reactor to allow an increased level of plutonium-enriched fuel use; (4) the



AEC's review, arising from disclosure of a geological fault, of the North Anna River, Virginia, nuclear facility. A fifth case documents a series of public meetings conducted in Pennsylvania by the Governor's Energy Council to consider the energy park concept. The sixth study was a narrative history and analysis of RM-50-1, a rulemaking proceeding conducted by the AEC in 1972 and 73 on emergency core cooling system operating standards. GRA

**N79-19429#** Monsanto Research Corp., Dayton, Ohio.  
**SOURCE ASSESSMENT: OPEN MINING OF COAL STATE OF THE ART Final Report, Sep. 1974 - Sep. 1977**  
 S. J. Rusek, S. R. Archer, R. A. Wachter, and T. R. Blackwood  
 Sep. 1978 90 p refs  
 (Contract EPA-68-02-1874)  
 (PB-288497/1; MRC-DA-709; EPA-600/2-78-004X) Avail:  
 NTIS HC A05/MF A01 CSCL 13B

Atmospheric emissions from the open mining of coal were studied. The potential environmental effect of this emission source is evaluated using source severity, defined as the ratio of the maximum ground-level concentration of a pollutant at a representative plant boundary to a hazard factor. The hazard factor is the ambient air quality standard for criteria pollutants and an adjusted threshold limit value for other pollutants. Respirable dusts are generated from five unit operations and from wind erosion. GRA

**N79-19439** Johns Hopkins Univ., Baltimore, Md.  
**SOLAR HEATING OF BUILDINGS: DESIGN OPTIMIZATION AND ECONOMIC ANALYSIS Ph.D. Thesis**  
 Arthur Edwin McGarity 1979 163 p  
 Avail: Univ. Microfilms Order No. 7906470

The problem of the design and economic analysis of solar heated buildings is treated as a multivariable optimization problem involving collector area, storage volume, and heating load reduction as decision variables. A mathematical programming optimization model employing a hybrid basic descent method is developed and is used to generate optimal area-volume paths which describe the cost minimizing combinations of collector area and storage volume for solar space heating systems which provide various fractions of the heating load (solar fractions). Dissert. Abstr.

**N79-19440** Stanford Univ., Calif.  
**ALTERNATIVE MODELS OF ENERGY DEMAND Ph.D. Thesis**  
 Sergio Granville 1978 169 p  
 Avail: Univ. Microfilms Order No. 7905870

The relationship between three aggregate inputs to the U.S. economy: value added by capital and labor, electric energy, and nonelectric energy was studied. The analysis consisted of an attempt to obtain improved econometric estimates of two demand elasticity parameters: the elasticity of substitution between energy and value added and the elasticity of substitution between electric and nonelectric energy. The short-run forecasting performance and the energy policy implications of the three alternative sets of demand elasticity parameters were examined. Dissert. Abstr.

**N79-19442** Massachusetts Univ., Amherst.  
**ENERGY ANALYSES APPLIED TO OCEAN THERMAL ENERGY CONVERSION AND AN OFFSHORE WIND POWER SYSTEM Ph.D. Thesis**  
 Tage Carl Gerald Carlson 1978 167 p  
 Avail: Univ. Microfilms Order No. 7901982

The primary concern for the dwindling fossil energy supplies in this country has led to an increased use of energy analyses and large scale energy modeling as a major input to energy policy decisions. Currently the more prominent energy analyses used are: net energy analysis, dynamic energy analysis, input-output matrix analysis, and second law of thermodynamics analysis. In addition, four large scale energy models were also generated. Each of the models and analyses are explained and examined with a comparison and critique given on each. It is concluded that at the present time, no single energy analysis technique or model will provide all the necessary information on which an energy policy decision can be based. Dissert. Abstr.

**N79-19444** California Univ., Berkeley.  
**EVALUATION OF THE USE OF OXYGEN AS OXIDANT IN FOSSIL FUEL FIRED OPEN CYCLE MHD-STEAM ENERGY CONVERSION PROCESSES Ph.D. Thesis**  
 Habib Amin 1978 121 p  
 Avail: Univ. Microfilms Order No. 7904362

The thermodynamics and economics of using oxygen versus air as the oxidant in large coal-fired MHD-steam energy conversion plants were evaluated and compared. Coal burned with oxygen produces combustion gases of very high temperature and of relatively high electrical conductivity. As a result of the reduction in gas flow that is a consequence of combustion with oxygen, there are significant reductions in the sizes and costs of required preheaters, MHD ducts, and superconducting magnets. Furthermore, combustion with high purity oxygen minimizes air pollution problems related to the conversion of molecular nitrogen oxides. The reduction in SO<sub>2</sub> and particulates control costs as a result of the decrease in combustion gas flow rate is analyzed. The major disadvantage of coal combustion with oxygen is found to be the energy and capital cost required for the oxygen plant. Throughout the study, the advantages and disadvantages of using oxygen are evaluated and compared for selected power generation systems. Dissert. Abstr.

**N79-19445** California Univ., Berkeley.  
**V-GROOVE MULTI-JUNCTION SOLAR CELLS Ph.D. Thesis**  
 Terry Ivan Chappell 1978 130 p  
 Avail: Univ. Microfilms Order No. 7904404

A study of three components which can be used in a solar utilization system are described. The three components are: a photovoltaic converter, an intensity sensor, and a selective thermal absorber. The results of extensive computer simulations, theoretical analyses, and measurements are reported for these components. A new family of silicon photovoltaic devices called V-Groove Multi-Junction (VGMJ) solar cells are described. The details of the fabrication for the Type 6 VGMJ solar cells is also described. The design of a silicon sensor intended for use in rapid-scan solar flux mapping at high illumination intensities is discussed. The characteristics of a water absorber in front of a silicon solar cell are quantified through the use of computer simulations and measurements. Dissert. Abstr.

**N79-19446** Massachusetts Univ., Amherst.  
**TWO-DIMENSIONAL ANALYSIS OF VERTICAL AXIS WINDMILLS Ph.D. Thesis**  
 Edward S. VanDusen 1978 296 p  
 Avail: Univ. Microfilms Order No. 7903857

A two-dimensional inviscid flow model is developed for vertical axis windmills with two foils of arbitrary shape. The solution is in the reference frame of the rotating foils and includes a time developing wake as vorticity is shed from the trailing edge of each foil. The results from different time steps, hence rotor orientations, are presented as plots of torque, streamlines, and power coefficient over a wide range of tip speed ratios. A heuristic stall model to account for flow separation is included in a manner that anticipates future viscous analysis. Results investigating the time step between solutions and different geometries are presented and compared to empirical values. Dissert. Abstr.

**N79-19447\*** National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.  
**SOLAR CELL MODULE ASSEMBLY JIG Patent**  
 Herbert W. O'Farrell, inventor (to NASA) (TRW Inc., Redondo Beach, Calif.) Issued 26 Jul. 1966 8 p Filed 10 Jun. 1963 (NASA-Case-XGS-00829-1; US-Patent-3,262,694; US-Patent-Appl-SN-286824; US-Patent-Class-269-153) Avail: US Patent and Trademark Office CSCL 10A

The invention relates to the manufacture of solar cell modules and more particularly to a jig for assembling, positioning and maintaining the components under resilient pressure, while the entire assembly and the jig is subjected to heat for simultaneously soldering all of the various circuit connections; as well as structurally bonding the layers into a strong light weight structure which minimizes the tendency of the solar cells to crack and the other components and electrical connections to fracture.

Official Gazette of the U.S. Patent and Trademark Office

**N79-19449# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.  
PRIMARY LITHIUM BATTERY TECHNOLOGY AND ITS  
APPLICATION TO NASA MISSIONS**

H. A. Frank 15 Feb. 1979 30 p refs

(Contract NAS7-100)

(NASA-CR-158229; JPL-Pub-79-6)

Avail: NTIS

HC A03/MF A01 CSCL 10C

A description is given of the components, overall cell reactions, and performance characteristics of promising new ambient temperature lithium primary systems based on the Li-V2O5, Li-SO2, and Li-SOCl2 couples. Development status of these systems is described in regard to availability and uncertainties in the areas of safety and selected performance characteristics. Studies show that use of lithium batteries would enhance a variety of missions and applications by decreasing power systems weight and thereby increasing payload weight. In addition, the lithium batteries could enhance cost effectiveness of the missions. G.Y.

**N79-19450# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.  
BIOCONVERSION STUDY CONDUCTED BY JPL**

John Kalvinskis 15 Nov. 1978 124 p refs

(Contract NAS7-100)

(NASA-CR-158228; JPL-Pub-79-9)

Avail: NTIS

HC A06/MF A01 CSCL 10A

The Jet Propulsion Laboratory (JPL) of Caltech conducted a study of bioconversion as a means of identifying the role of biomass for meeting the national energy fuel and chemical requirements and the role and means for JPL-Caltech involvement in bioconversion. The bioconversion study included the following categories: biomass sources, chemicals from biomass, thermochemical conversion of biomass to fuels, biological conversion of biomass to fuels and chemicals, and basic bioconversion sciences. A detailed review is included of the bioconversion fields cited with specific conclusions and recommendations given for future research and development and overall biomass system engineering and economic studies. Author

**N79-19451# Technical Marketing Associates, Inc., Concord, Mass.**

**MARKET DEFINITION STUDIES FOR PHOTOVOLTAIC  
HIGHWAY APPLICATIONS**

Dec. 1978 121 p

(Contracts DEN-3-40; DE-A101-79ET20485)

(NASA-CR-159477; DOE/NASA/0040-78/1) Avail: NTIS

HC A06/MF A01 CSCL 10A

Prospects for solar electric power in applications related to highways within the continental United States are examined. Principal prospective users are found to be the highway departments of the various states. Economic analysis is employed to demonstrate that suitable applications can occur when powering apparatus such as signs, crossing signals, or instruments which consume less than 100 watts on the average, provided they are located at least one-half mile from existing utility power. Such applications are projected to occur two or three times per state per year. Attitudes of highway officials toward possible use of solar power are sampled and described. Although falling photovoltaic cell prices are expected to have little effect on sales potential here, methods for federal stimulation of this market are discussed. G.Y.

**N79-19453# Honeywell, Inc., Minneapolis, Minn.  
PRELIMINARY DESIGN PACKAGE FOR RESIDENTIAL  
HEATING/COOLING SYSTEM: RANKINE AIR CONDITIONER  
REDESIGN**

Dec. 1978 109 p Prepared for DOE

(Contract NAS8-32093)

(NASA-CR-150871) Avail: NTIS HC A06/MF A01 CSCL 10A

A summary of the preliminary redesign and development of a marketable single family heating and cooling system is presented. The interim design and schedule status of the residential (3-ton) redesign, problem areas and solutions, and the definition of plans for future design and development activities were discussed. The proposed system for a single-family residential heating and cooling system is a single-loop, solar-assisted, hydronic-to-warm-air heating subsystem with solar-assisted domestic water heating

and a Rankine-driven expansion air-conditioning subsystem.

Author

**N79-19454# Comstock and Wescott, Inc., Cambridge, Mass.  
DEVELOPMENT OF A PHASE-CHANGE THERMAL STORAGE  
SYSTEM USING MODIFIED ANHYDROUS SODIUM  
HYDROXIDE FOR SOLAR ELECTRIC POWER GENERATION**

Barry M. Cohen, Richard E. Rice, and Peter E. Rowny Dec. 1978 252 p refs Prepared for DOE

(Contracts NAS3-20615; EC-77-A-31-1034)

(NASA-CR-159465; DOE/NASA/0615-79/1) Avail: NTIS

HC A12/MF A01 CSCL 10A

A thermal storage system for use in solar power electricity generation was investigated analytically and experimentally. The thermal storage medium is principally anhydrous NaOH with 8% NaNO3 and 0.2% MnO2. Heat is charged into storage at 584 K and discharged from storage at 582 K by Therminol-66. Physical and thermophysical properties of the storage medium were measured. A mathematical simulation and computer program describing the operation of the system were developed. A 1/10 scale model of a system capable of storing and delivering 3.1 x 10 to the 6th power kJ of heat was designed, built, and tested. Tests included steady state charging, discharging, idling, and charge-discharge conditions simulating a solar daily cycle. Experimental data and computer-predicted results are correlated. A reference design including cost estimates of the full-size system was developed. Author

**N79-19455# Copper Development Association, Inc., New York, N. Y.**

**FINAL SYSTEM INSTRUMENTATION DESIGN PACKAGE  
FOR DECADE 80 SOLAR HOUSE**

Dec. 1978 69 p refs

(Contract NAS8-32244)

(NASA-CR-150869) Avail: NTIS HC A04/MF A01 CSCL 10A

The final configuration of the Decade 80 solar house to monitor and collect system performance data is presented. A review demonstrated by actual operation that the system and the data acquisition subsystem operated satisfactorily and installation of instrumentation was in accordance with the design. This design package is made up of (1) site and system description, (2) operating and control modes, and (3) instrumentation program (including sensor schematic). M.M.M.

**N79-19456# Solarix Corp., Rockville, Md.  
DEVELOPMENT OF AN IMPROVED HIGH EFFICIENCY TWIN  
SILICON SOLAR CELL Quarterly Report**

C. Wrigley and G. Storti Jul. 1978 10 p

(Contracts NAS7-100; JPL-954883)

(NASA-CR-158172; SX/115/30; QR-3) Avail: NTIS

HC A02/MF A01 CSCL 10A

Efforts were directed towards investigating means of producing more effective high-low junctions at the back of the cell. Cells with output power up to 77 mW (AMO efficiency of 14.2 percent) were fabricated. Some reflectivity studies were also made. Deliveries of 2 cm x 2 cm experimental cells included a number having AMO outputs greater than 70 mW. L.S.

**N79-19457# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.  
THERMAL AND OTHER TESTS OF PHOTOVOLTAIC  
MODULES PERFORMED IN NATURAL SUNLIGHT**

J. W. Stultz 31 Jul. 1978 58 p refs Sponsored by NASA

and DOE

(NASA-CR-158174; JPL-5101-76; DOE/JPL-1012-78/9) Avail:

NTIS HC A04/MF A01 CSCL 10A

The bulk of the testing was the characterization of twenty-nine modules according to their nominal operating cell temperature (NOCT) and the effect on NOCT of changes in module design, various residential roof mounting configurations, and dirt accumulation. Other tests, often performed parallel with the NOCT measurements, evaluated the improvement in electrical performance by cooling the modules with water and by channeling the waste heat into a phase change material (wax). Electrical degradation resulting from the natural marriage of photovoltaic and solar water heating modules was also demonstrated. Cost

effectiveness of each of these techniques are evaluated in light of the LSA cost goal of \$0.50 per watt. L.S.

**N79-19461#** Council on Environmental Quality, Washington, D.C.

**THE GOOD NEWS ABOUT ENERGY**

1979 64 p refs

Avail: NTIS MF A01; SOD HC

A project was undertaken to investigate the potential for achieving lower energy growth in the United States and the implications of this low energy growth for the economy, the environment and government policy. The overall conclusion is that the United States can do well, indeed prosper, on much less energy than has been commonly supposed. The principal basis for this is the accumulating evidence that the means are available to wring far more consumer goods and services out of each unit of fuel that is used, whether it be a barrel of oil or a ton of coal or uranium. L.S.

**N79-19462\*#** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena. **LSA LOW-COST SOLAR ARRAY PROJECT Quarterly Report, Oct. - Dec. 1977**

Dec. 1977 76 p Sponsored by NASA and DOE

(NASA-CR-158250; JPL-5101-81; QR-7;

DOE/JPL-1012-78/13; JPL-Pub-78-97)

Avail: NTIS

HC A05/MF A01 CSCL 10A

The activities of the Low-Cost Silicon Solar Array Project during the period October through December, 1977 are reported. The LSSA Project is assigned responsibility for advancing silicon solar array technology while encouraging industry to reduce the price of arrays to a level at which photovoltaic electric power systems will be competitive with more conventional power sources early in the next decade. Set forth are the goals and plans with which the Project intends to accomplish this and the progress that was made during the quarter. G.Y.

**N79-19467#** National Bureau of Standards, Washington, D. C. Center for Building Technology.

**GEOGRAPHICAL VARIATION IN THE HEATING AND COOLING REQUIREMENTS OF A TYPICAL SINGLE-FAMILY HOUSE, AND CORRELATION OF THESE REQUIREMENTS TO DEGREE DAYS**

Edward A. Arens and William L. Carroll Nov. 1978 64 p refs Sponsored in part by HUD and Assistant Sec. for Policy Develop. and Res.

(Contract E(49-1)-3800)

(PB-289204/0; NBS-BSS-116)

Avail: NTIS

HC A04/MF A01 CSCL 10A

Test Reference Year (TRY) hourly climate data tapes are assessed to determine how well they represent long-term average climate when used for estimating average annual heating and cooling requirements. A method to adjust heating and cooling requirements is presented. The geographic variations of annual heating and cooling requirements across the U.S. are quantified by computing the heating and cooling requirements of a typical ranch-style residence for the 8760 hours of each of the 60 TRY tapes and the results are adjusted. The effectiveness of degree-day data for predicting these computed annual heating and cooling requirements is examined, and the variability of heating and cooling requirements within degree-day zones of 1000 degree-day width is presented. GRA

**N79-19468#** AIA Research Corp., Washington, D. C. **PHASE ONE/BASE DATA FOR THE DEVELOPMENT OF ENERGY PERFORMANCE STANDARD FOR NEW BUILDINGS. TASK REPORT: BUILDING CLASSIFICATION**

12 Jan. 1978 131 p

(Contract HUD-H-2889)

(PB-286904/8; HUD-0000194)

Avail: NTIS

HC A07/MF A01 CSCL 13A

Building classifications to aid in the derivation of energy performance standards for the construction of new buildings are presented. An effort was made to develop a system of building classifications appropriate to the collection of data on designed energy performance and the implementation of national energy performance standards under Title III of the Energy Conserva-

tion and Production Act. Two classification schemes are described: a general classification system encompassing all building types using energy for space conditioning, and an abbreviated classification system for data collection that includes only building types expected to contribute significantly to construction volume over the next 10 years. GRA

**N79-19469#** Nuclear Regulatory Commission, Washington, D. C. Cost-Benefit Analysis Branch.

**COAL AND NUCLEAR: A COMPARISON OF THE COST OF GENERATING BASELOAD ELECTRICITY BY REGION**

Jack O. Roberts, Sarah M. Davis, and Darrel A. Nash Dec. 1978 113 p

(PB-289585/2; NUREG-0480) Avail: NTIS HC A06/MF A01 CSCL 10B

The results of an economic comparison by region of coal and nuclear fueled electric generating options that may be available to utilities during the late 1980's and early 1990's are reported. Some of the many factors that may be considered by public agencies and electric utilities in planning to meet future electric energy needs are discussed. The timeframe is for generating units now in the planning stages and units which are expected to enter the licensing phase over the next few years. These generating units would enter the operational phase in the late 1980's. GRA

**N79-19470#** Society of Petroleum Industry Biologists, Los Angeles, Calif.

**ENERGY/ENVIRONMENT-1978: SYMPOSIUM ON ENERGY DEVELOPMENT IMPACTS**

June Lindstedt-Siva Aug. 1978 340 p Symp. held at Los Angeles, Calif., 22-24 Aug. 1978

(PB-288578/8; LC-78-110283)

Avail: NTIS

HC A15/MF A01 CSCL 13B

The Proceedings volume contains 27 papers on subjects such as the management and use of biological and archaeological baseline data; ecological impacts of energy development (coal mines, offshore oil, power plants, pipelines); energy development and public policy; oil spills; fate and effects and minimizing the environmental impacts of oil spills. GRA

**N79-19472#** General Accounting Office, Washington, D. C. Energy and Minerals Div.

**EVALUATION OF FOUR ENERGY CONSERVATION PROGRAMS-FISCAL YEAR 1977**

21 Nov. 1978 90 p

(PB-288825/3; EMD-78-81) Avail: NTIS HC A05/MF A01 CSCL 10A

The report reviews four programs: Energy conservation and renewable-resource obligation guarantees, national energy conservation and renewable-resource demonstration for existing dwelling units, supplemental State energy conservation plans, and weatherization assistance for low-income persons. GRA

**N79-19488#** Environmental Protection Agency, Ann Arbor, Mich. Technical Assessment and Evaluation Branch.

**EFFECTS OF LOW AMBIENT TEMPERATURE ON THE EXHAUST EMISSIONS AND FUEL ECONOMY OF 84 AUTOMOBILES IN CHICAGO**

Wayne Heinmiller Oct. 1978 25 p refs

(PB-288400/5) Avail: NTIS HC A02/MF A01 CSCL 13F

The results of a project are described in which pairs of tests were conducted in 84 in-use passenger cars, once under low temperature conditions (16 F to 57 F), and again under standard laboratory conditions. Each sequence included the 1975 Federal Test Procedure (exhaust emissions only), the Highway Fuel Economy Test and three short cycle tests. The vehicles were randomly obtained, tested in an as-received condition, and work was performed between January and March 1978. Results show that HC and CO are most sensitive to cold temperature, while NOX is affected only slightly. Fuel economy suffered by an average of 7%. Vehicle fleets from manufacturers which used different control technologies were found to behave considerably differently at low temperatures. GRA

**N79-19496#** Water Purification Associates, Cambridge, Mass.  
**WATER-RELATED ENVIRONMENTAL EFFECTS IN FUEL CONVERSION. VOLUME 2: APPENDICES Final Report.**  
 Oct. 1976 - Sep. 1978

David J. Goldstein Oct. 1978 666 p refs  
 (Contract EPA-68-03-2207)  
 (PB-288874/1; EPA-600/7-78-197B-Vol-2) Avail: NTIS  
 HC A99/MF A01 CSCL 07A

Results of an examination of water-related effects that can be expected from siting conversion plants in the major U.S. coal and oil shale bearing regions are reported. Ninety plant-site combinations were studied: 48 in the Central and Eastern U.S. and 42 in the Western. Synthetic fuel technologies examined include: coal gasification to convert coal to pipeline gas; coal liquefaction to convert coal to low sulfur fuel oil; coal refining to produce a de-ashed, low-sulfur solvent refined (clean) coal; and oil shale retorting to produce synthetic crude. The range of water requirements, conditions for harrowing the range and optimizing the use of water, ranges of residual solid wastes; and cost and energy requirements for wastewater treatment are presented. GRA

**N79-19506** California Univ., Berkeley.  
**SEISMOLOGICAL INVESTIGATIONS IN GEOTHERMAL REGIONS Ph.D. Thesis**

Ernest Luther Majer 1978 232 p  
 Avail: Univ. Microfilms Order No. 7904540

Seismological methods, including studies of microearthquakes, P- and S-wave velocities and P-wave attenuation were investigated as tools for the exploration and delineation of geothermal resources. Seismograms from explosions and microearthquakes were examined for changes in frequency content and relative arrival times across a known geothermal area, The Geysers, California and a potential geothermal region, Grass Valley, Nevada. Microearthquakes within the two regions were examined for evidence of spatial variations in radiated P- and S-waves. Additional information concerning basin and range structure was provided by regional refraction studies. Detailed structural analysis in Grass Valley was obtained by commercial reflection and refraction work. Heat flow modeling, consistent with structure inferred by seismological techniques, was used to discriminate between conductive and convective heat flow anomalies in Grass Valley. r Dissert. Abstr.

**N79-19521#** National Aeronautics and Space Administration.  
 Pasadena Office, Calif.  
**BOREHOLE GEOLOGICAL ASSESSMENT Patent Application**

William Spuck, III, inventor (to NASA) (JPL) Filed 4 May 1978  
 19 p Sponsored by NASA  
 (NASA-Case-NPO-14231-1; US-Patent-Appl-SN-903019) Avail:  
 NTIS HC A02/MF A01 CSCL 08G

A method and apparatus are provided for performing geological assessments of a formation located along a borehole, which includes a boring tool that bores a pair of holes into the walls of the borehole and into the surrounding strata, and a pair of probes installed in the holes. One of the probes applies an input such as a current or pressured fluid, and the other probe senses a corresponding input which it receives from the strata. The boring tool can include a series of rigid bore segments that can be easily installed in a housing that lies in the borehole, and apparatus for connecting the bore segments in series while also advancing them into the strata surrounding the borehole, so that a straight hole can be bored in the strata. NASA

**N79-19563#** Oregon State Univ., Corvallis. Sea Grant Coll.  
 Program.

**GEOTHERMAL RESOURCES FOR AQUACULTURE**  
 Sep. 1978 51 p Workshop held in Boise, Idaho, 13-15 Dec. 1977 Sponsored by NOAA  
 (PB-290345/8; ORESU-W-78-001; NOAA-78102401) Avail:  
 NTIS HC A04/MF A01 CSCL 08G

The workshop sought consensus on the potential of geothermal aquaculture for commercial success. Geothermal sites in

the United States Pacific Northwest may represent useful locations for commercial freshwater aquaculture. Awareness of this opportunity stems from the research observation that warmed water increases growth rates of certain species of fish and shellfish, and from the fact that some of these geothermal sites have already been tapped for electric power generation and other uses. Questions addressed included: what species can or should be produced; what biological constraints exist through nutrition, disease, or husbandry, and what engineering, economic, marketing, or institutional and legal problems must be solved. Research, training, and advisory needs were identified and priorities described. GRA

**N79-19568#** Battelle Pacific Northwest Labs., Richland, Wash.  
**WIND CHARACTERISTICS PROGRAM ELEMENT**  
**Annual Report, Jul. 1977 - Jul. 1978**

L. L. Wendell, J. R. Connell, W. T. Pennell, D. S. Renne, and H. L. Wegley Dec. 1978 130 p refs  
 (Contract EY-76-C-06-1830)

(PNL-2545; UC-60) Avail: NTIS HC A07/MF A01

This annual report to the wind systems branch of the Department of Energy's (DOE's) Division of Distributed Solar Technology describes the technical progress within each program area from July 1977 through July 1978. The progress is presented which was accomplished directly by PNL, by other DOE laboratories and by contractors funded directly by DOE or through PNL. The wind velocity change criteria for wind turbine design along with techniques for incorporating data into large area analysis are discussed. The publications on methodology for small wind energy conversion and wind forecasts are also reported. M.M.M.

**N79-19928** Cornell Univ., Ithaca, N. Y.  
**THE ANAEROBIC ATTACHED FILM EXPANDED BED REACTOR FOR THE TREATMENT OF DILUTE ORGANIC WASTES Ph.D. Thesis**

Michael Samuel Switzenbaum 1978 205 p  
 Avail: Univ. Microfilms Order No. 7902370

A process, the anaerobic attached film expanded bed reactor (AAFEB) has been found to be effective for the treatment of low strength soluble organic wastes anaerobically, at reduced temperatures, at short retention times, and at high organic loading rates. An analysis of the key process variables which affected AAFEB operation and two simplified first order equations relating the process efficiency to the net specific growth rate of the film and specific substrate utilization two widely used operational parameters which are based on fundamentals of microbial growth and energetics, are presented. Dissert. Abstr.

**N79-20109#** Dynamics Research Corp., Wilmington, Mass.  
 Systems Div.

**AN ANALYSIS OF FUEL CONSERVING OPERATIONAL PROCEDURES AND DESIGN MODIFICATIONS FOR BOMBER/TRANSPORT AIRCRAFT, VOLUME 2 Final Report.**  
 7 Jun. 1976 - 7 Jul. 1978

Romesh K. Aggarwal Jul. 1978 508 p refs  
 (Contract F33615-76-C-3104)  
 (AD-A062609; R-247U; AFFDL-TR-78-96-Vol-2) Avail: NTIS  
 HC A22/MF A01 CSCL 01/3

Various proposed improvements in the design and operational procedures for bomber/transport aircraft are evaluated. The evaluation is performed in terms of the estimated savings in fuel consumption and in Direct Operating Cost (DOC). As an aid in the evaluation of design modifications, graphs of fuel and DOC savings as a function of the design parameters are developed. These graphs are based on actual mission trajectory data rather than some typical trajectory profile. The actual mission data is presented in terms of histograms which provide statistical information concerning altitude, air speed, take-off weight, landing weight, and mission time. Separate analyses are performed on the following aircraft: the B-52G, the B-52H, the KC-135, the C-141, the C-130, and the C-5A. Author (GRA)

**N79-20114\*** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

**PARAMETRIC PERFORMANCE OF A TURBOJET ENGINE COMBUSTOR USING JET A AND A DIESEL FUEL**

Helmuth F. Butze and Francis M. Humenik Mar. 1979 44 p refs

(NASA-TM-79089; E-9913) Avail: NTIS HC A03/MF A01 CSCL 21E

The performance of a single-can JT8D combustor was evaluated with Jet A and a high-aromatic diesel fuel over a parametric range of combustor-inlet conditions. Performance parameters investigated were combustion efficiency, emissions of CO, unburned hydrocarbons, and NO<sub>x</sub>, as well as liner temperatures and smoke. At all conditions the use of diesel fuel instead of Jet A resulted in increases in smoke numbers and liner temperatures; gaseous emissions, on the other hand, did not differ significantly between the two fuels. Author

**N79-20118\*** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

**TESTS OF NASA CERAMIC THERMAL BARRIER COATING FOR GAS-TURBINE ENGINES**

Curt H. Liebert 1979 10 p refs Presented at the Intern. Conf. on Met. Coatings, San Diego, Calif., 23-27 Apr. 1979

(NASA-TM-79116; E-9846-1) Avail: NTIS HC A02/MF A01 CSCL 21E

A two-layer thermal barrier coating system with a bond coating of nickel-chromium-aluminum-yttrium and a ceramic coating of yttria-stabilized zirconia was tested for corrosion protection, thermal protection and durability. Full-scale gas-turbine engine tests demonstrated that this coating eliminated burning, melting, and warping of uncoated parts. During cyclic corrosion resistance tests made in marine diesel fuel products of combustion in a burner rig, the ceramic cracked on some specimens. Metallographic examination showed no base metal deterioration. S.E.S.

**N79-20179\*** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

**CLOSED LOOP SOLAR ARRAY-ION THRUSTER SYSTEM WITH POWER CONTROL CIRCUITRY Patent**

Robert P. Gruber, inventor (to NASA) Issued 6 Mar. 1979 8 p Filed 29 Mar. 1978 Supersedes N78-22149 (16 - 13, p 1873)

(NASA-Case-LEW-12780-1; US-Patent-4,143,314;

US-Patent-Appl-SN-891370; US-Patent-Class-323-15;

US-Patent-Class-323-20) Avail: US Patent and Trademark Office CSCL 20C

A power control circuit connected between a solar array and an ion thruster receives voltage and current signals from the solar array. The control circuit multiplies the voltage and current signals together to produce a power signal which is differentiated with respect to time. The differentiator output is detected by a zero crossing detector and, after suitable shaping, the detector output is phase compared with a clock in a phase demodulator. An integrator receives no output from the phase demodulator when the operating point is at the maximum power but is driven toward the maximum power point for non-optimum operation. A ramp generator provides minor variations in the beam current reference signal produced by the integrator in order to obtain the first derivative of power.

Official Gazette of the U.S. Patent and Trademark Office

**N79-20272#** Naval Research Lab., Washington, D. C.

**AGING BEHAVIOR OF CRUDE SHALE OIL Progress Report**

Robert N. Hazlett, James M. Hall, and Jack C. Burnett Aug. 1978 11 p refs

(AD-A062420; AD-E000240; NRL-MR-3844) Avail: NTIS HC A02/MF A01 CSCL 11/8

Crude shale oil produced by the Paraho retort was heated for eight weeks at 50 C. This corresponds to at least one year of storage at ambient conditions. Increases in oil viscosity and in the content of high molecular weight compounds were observed, but pour point changes were minimal. The overall changes at the experimental conditions used are modest.

Author (GRA)

**N79-20279#** Southwest Research Inst., San Antonio, Tex. Army Fuels and Lubricants Research Lab.

**DIRECT UTILIZATION OF CRUDE OIL AS FUEL IN THE US ARMY FOUR-CYCLE DIESEL ENGINE, MODEL LDT-465-1C Interim Report, Apr. 1977 - Aug. 1978**

John V. Moffitt and Edwin A. Frame Aug. 1978 34 p refs (Contracts DAAG53-76-C-0003; DAAK70-78-C-0001)

(AD-A062387; AFLRL-108) Avail: NTIS HC A03/MF A01 CSCL 21/7

Performance curves for the U.S. Army LDT-465-1C engine were obtained using DF-2 and crude oils of varying properties. A cyclic endurance test was run using crude oil as the fuel. The results of the crude oil fueled test were compared to tests where DF-2 fuel was used. The crude oil resulted in significantly more engine wear and deposition than the DF-2. With crude oil fuel, the lubricant was severely degraded at end of test.

Author (GRA)

**N79-20281\*** Siltec Corp., Menlo Park, Calif.

**LSA LARGE AREA SILICON SHEET TASK CONTINUOUS LIQUID FEED CZOCHRALSKI GROWTH Quarterly Report, Oct. - Dec. 1978**

George Fiegl Jan. 1979 28 p Sponsored by DOE

(Contract JPL-954886)

(NASA-CR-158366; DOE/JPL-954886-79/1; QR-5) Avail: NTIS HC A03/MF A01 CSCL 13H

A process for the continuous growth of crystals by the Czochralski method, suitable for producing single silicon crystals for use in solar cells was studied. Continuous growth is the growth of 100 Kg of single silicon crystals, 10 cm in diameter, from one container. A furnace with continuous liquid replenishment of the growth crucible, accomplished by a melt-down system and a liquid transfer mechanism, with associated automatic feedback controls was developed. Elements of the transfer system were further developed and tested during actual transfer runs. Considerable simplification of the heating element of the transfer tube was achieved. Accuracy and reliability of the temperature sensor, which is part of the power input control system, for the transfer tube, was improved. Electrical and thermal effectiveness were increased while assembly of the transfer tube system was further simplified.

Author

**N79-20282\*** Westinghouse Research and Development Center, Pittsburgh, Pa.

**SILICON WEB PROCESS DEVELOPMENT Quarterly Report, 1 Oct. - 31 Dec. 1978**

C. S. Duncan, R. G. Seidensticker, R. H. Hopkins, J. P. McHugh, F. E. Hill, M. E. Heimlich, and J. M. Driggers 1978 118 p refs Prepared for JPL

(Contract JPL-954654)

(NASA-CR-158376; ERDA/JPL-954654-79/1) Avail: NTIS HC A06/MF A01 CSCL 13H

Progress in the development of techniques to grow silicon web at 25 wq cm/min output rate is reported. Feasibility of web growth with simultaneous melt replenishment is discussed. Other factors covered include: (1) tests of aftertrimmers to improve web width; (2) evaluation of growth lid designs to raise speed and output rate; (3) tests of melt replenishment hardware; and (4) investigation of directed gas flow systems to control unwanted oxide deposition in the system and to improve convective cooling of the web. Compatibility with sufficient solar cell performance is emphasized.

J.M.S.

**N79-20291#** National Bureau of Standards, Washington, D. C. National Engineering Lab.

**SOLAR BUILDING REGULATORY STUDY, VOLUME 2**

Joe Greenberg Nov. 1978 385 p

(Contract EA-77-A-01-6010)

(PB-289824/5; NBS-GCR-78-141-2-Vol-2) Avail: NTIS HC A17/MF A01 CSCL 13A

The results of a project oriented toward obtaining the views of organizations representing diversified interests within the building community are documented regarding: (1) the need for a solar regulatory systems; and (2) the form such a system should take if indeed a solar regulatory systems were recommended.

GRA

**N79-20434** California Inst. of Tech., Pasadena.  
**ANALYTICAL MODELLING OF OIL RECOVERY BY STEAM INJECTION Ph.D. Thesis**

Yanis Christos Yortsos 1979 349 p  
 Avail: Univ. Microfilms Order No. 7904856

An extensive study of the heat transfer in the surroundings and the hot liquid zone is carried out to complement the one-dimensional implementation of the technique. The resulting class of moving boundary problems and their methods of solution are discussed in detail. The results obtained are then combined with the integral technique to derive upper and lower bounds, asymptotic solutions and approximate solutions to the rate of growth of the steam zone. The important physical parameters are identified and their significance in the design of the process is outlined. For two- (three-) dimensional systems, a more detailed version of the integral method is developed to account for the effect of gravity segregation in the determination of the steam front shape. A non-linear partial differential equation that described the evolution of the steam front shape in gravity dominated systems is derived. The significance of the various physical parameters in the performance of a three-dimensional steam injection process is discussed by providing a solution to the equation derived, in the limit of predominantly viscous flows. Dissert. Abstr.

**N79-20458#** Los Alamos Scientific Lab., N. Mex.  
**TOWARD ASSESSING THE GEOTHERMAL POTENTIAL OF THE JEMEZ MOUNTAINS VOLCANIC COMPLEX: A TELLURIC-MAGNETOTELLURIC SURVEY**

John F. Hermance (Brown Univ.) Feb. 1979 88 p refs  
 (Contract W-7405-eng-36)  
 (LA-7656-MS). Avail: NTIS HC A05/MF A01

Telluric-magnetotelluric studies were performed in the Jemez Mountains of north-central New Mexico to characterize the total geothermal system of the Valles Caldera and to be integrated with an east-west regional survey supported by the United States Geological Survey. The data from the regional survey indicate that electrically the San Juan Basin to the west of the Jemez Mountains is rather homogeneous in contrast to the eastern side near Las Vegas where the presence of a broad heterogeneous structure is clearly sensed. The data from the Jemez Mountain area are strikingly similar to other Rio Grande rift data and suggest a conducting layer at a depth of approximately 15 km. The telluric data indicate that the hydrothermal system in the area is of a localized nature. Author

**N79-20459#** Colorado School of Mines, Golden. Dept. of Geophysics.

**RESEARCH ON THE PHYSICAL PROPERTIES OF GEOTHERMAL RESERVOIR ROCK Quarterly Report**

C. K. Skokan and A. Ibrahim Jul. 1978 65 p refs  
 (Contract EY-76-S-02-2908)  
 (COO-2908-4). Avail: NTIS HC A04/MF A01

Laboratory measurements of thermal conductivity and capillary pressure undertaken for samples of Cenozoic Volcanic rocks collected from the Columbia Plateau Volcanic basin are presented. These measurements were performed at atmospheric pressure and room temperature. Various methods of measuring thermal conductivity were investigated and finally a flash method was chosen. The equipment was constructed and tested. Numerous capillary pressure curves were obtained by use of the mercury injection technique. These curves indicate pore structure: pore size, pore distribution, pore volume, and pore geometry. Measurements of this type help to explain variations in rock properties such as seismic velocities and resistivities. J.M.S.

**N79-20478#** Alabama Univ. in Huntsville. Kenneth E. Johnson  
 Environmental and Energy Center.

**COST ANALYSIS AND OPTIMIZATION STUDY FOR SOLAR HEATING AND COOLING SYSTEMS, STILLWATER, MINNESOTA AND NEWCASTLE, PENNSYLVANIA**

William L. Reid Nov. 1978 90 p  
 (Contract NAS8-31293)  
 (NASA-CR-161201). Avail: NTIS HC A05/MF A01 CSCL 10A

A detailed cost analysis study of two solar energy systems was performed, in order to derive specific quantified and potential cost savings, design refinements, and/or design innovations for each of the selected solar energy systems represented by selected operational test sites. Preliminary cost estimates are given for liquid type systems based on the second series of operational test sites studied: Stillwater, Minnesota and New Castle, Pennsylvania. J.M.S.

**N79-20480#** RCA Labs., Princeton, N. J.  
**AUTOMATED ARRAY ASSEMBLY, PHASE 2 Quarterly Report, 1 Jul. - 30 Sep. 1978**

R. V. Daiello Oct. 1978 42 p refs Sponsored in part by DOE

(Contracts NAS7-100; JPL-954868)  
 (NASA-CR-158380; DOE/JPL-954868-78/4; QR-4) Avail: NTIS HC A03/MF A01 CSCL 10A

The purpose of the overall program is to establish technological readiness and provide verification for the elements of a manufacturing sequence which would ultimately be suitable for the large-scale production of silicon solar-array modules at a selling price of less than \$500/kW. A program and process plan for accomplishing this objective was developed and put into operation. Three junction-formation processes are shown; since cost analysis shows that they do not differ greatly in cost, each should be considered for technical merits and possible future cost reduction. The progress made in the various process steps of the plan is described, and conclusions are presented. LS.

**N79-20481#** Lockheed Missiles and Space Co., Sunnyvale, Calif.

**AUTOMATED ARRAY ASSEMBLY, PHASE 2. LOW-COST SOLAR ARRAY PROJECT, TASK 4 Final Report**

Mike Lopez Oct. 1978 112 p refs Sponsored by DOE  
 (Contract JPL-954898)

(NASA-CR-158365; LMSC-D632522; DOE/JPL-954898-78/4) Avail: NTIS HC A06/MF A01 CSCL 10A

Work was done to verify the technological readiness of a select process sequence with respect to satisfying the Low Cost Solar Array Project objectives of meeting the designated goals of \$50 per peak watt in 1986 (1975 dollars). The sequence examined consisted of: (1) 3 inches diameter as-sawn Czochralski grown 1:0:0 silicon, (2) texture etching, (3) ion implanting, (4) laser annealing, (5) screen printing of ohmic contacts and (6) sprayed anti-reflective coatings. High volume production projections were made on the selected process sequence. Automated processing and movement of hardware at high rates were conceptualized to satisfy the PROJECT's 500 MW/yr capability. A production plan was formulated with flow diagrams integrating the various processes in the cell fabrication sequence. LS.

**N79-20482#** Schumacher (J. C.) Co., Oceanside, Calif.  
**THE PRODUCTION OF SOLAR CELL GRADE SILICON FROM BROMOSILANES Final Report**

J. C. Schumacher, L. Woerner, E. Moore, and C. Newman Jan. 1979 70 p refs Sponsored in part by DOE  
 (Contract JPL-954914)

(NASA-CR-158362; SE-655; DOE/JPL-954914-78/2) Avail: NTIS HC A04/MF A01 CSCL 10A

A continuous Flow Reactor (CFR) process based on the hydrogen reduction of the bromosilanes SiBr<sub>4</sub> and SiHBr<sub>3</sub> was proposed. Initial experiments carried and directed at obtaining overall yield data for bromosilane reduction in the CFR, indicated the need for increased reactor residence time and deposition substrate particle packing density to fully characterize the kinetics (rate) and thermodynamics (yield) of observed silicon production. Fluidized bed experiments were therefore initiated to overcome these experimental difficulties, which showed both thermal decomposition and hydrogen reduction of SiHBr<sub>3</sub> in a fluid bed reactor to present attractive closed-loop processes for producing solar cell grade polycrystalline silicon. No process selection could be made however due to the fact that preliminary optimization of 2 of 3 process stages in each case during the course of the experimental program showed comparable attainment of cost element objectives. J.M.S.

N70-20403°/ Mobil Tyco Solar Energy Corp., Waltham, Mass.  
 LARGE AREA SILICON SHEET BY EFG  
 Annual Progress Report, 1 Oct. 1977 - 30 Sep. 1978  
 F. V. Wold 18 Feb. 1979 79 p refs Prepared for JPL  
 (Contract JPL-954355)  
 (NASA-CR-158379; DOE/JPL-954355-78/3) Avail: NTIS  
 HC A05/MF A01 CSCL 10A

Progress made in the development of EFG ribbon growth is discussed. Specific areas covered include: (1) demonstration of multiple growth for ribbons 5 cm wide in runs of 12 and 20 hours duration; (2) a single cartridge crystal growth station was built expanding observational capacity by virtue of an anamorphic optical-video system which allows close observation of the meniscus over 7.5 cm wide, as well as video taping of the ribbon growth process; (3) growth station no. 1 achieved reproducible and reliable growth of 7.5 cm wide ribbon at speeds up to 4 cm/min; (4) introduction of the 'mini cold shoe'; (5) increases in cell efficiency due to interface shaping using the 'displaced die' concept; and (6) clarification of the role of gaseous impurities in cartridge furnaces and stabilization of their destabilizing influence on growth. J.M.S.

N70-20404°/ Westinghouse Research and Development Center, Pittsburgh, Pa.  
 PHASE TWO OF THE ARRAY AUTOMATED ASSEMBLY  
 TASK FOR THE LOW COST SOLAR ARRAY PROJECT  
 Quarterly Report, 1 Oct. - 31 Dec. 1978  
 R. B. Campbell, D. J. Page, P. Rai-Choudhury, E. J. Seman, M. H. Hanes, A. Rohatsi, and J. R. Davis 31 Jan. 1979 44 p refs Sponsored in part by DOE  
 (Contracts NAS7-100; JPL-954873)  
 (NASA-CR-158359; QR-5) Avail: NTIS HC A03/MF A01 CSCL 10A

Various top contact metal systems were studied. Only Ti Pd Cu approaches baseline (Ti Pd Ag) quality, but this system shows a lack of long term stability. Aluminum back surface field structures were fabricated and thicknesses of p superscript + material of up to 7.0 microns were achieved with open circuit voltages of 0.59V. A general purpose ultrasonic welder was purchased and tests using various metal foils are under way. During fabrication of the demonstration module, several cells became cracked. Due to redundancy of interconnections, the module was not open circuited but the efficiency was reduced to 8.8%. The broken cell was interconnected with a strap across the back and the efficiency was increased to 11.5%. A cost analysis was made and the results indicate a selling price of \$0.56/watt peak (in 1986 with 1975 dollars). L.S.

N70-20405°/ Optical Coating Lab., Inc., City of Industry, Calif.  
 Photoelectronics Div.  
 SILICON SOLAR CELL PROCESS DEVELOPMENT, FABRI-  
 CATION AND ANALYSIS Quarterly Report, 1 Oct. - 31 Dec.  
 1978  
 H. I. Yoo, P. A. Iles, and D. P. Tanner 31 Dec. 1978 71 p refs Sponsored in part by DOE  
 (Contract JPL-955089)  
 (NASA-CR-158363; DOE/JPL-955089-79/1; QR-2) Avail:  
 NTIS HC A04/MF A01 CSCL 10A

Ribbon to Ribbon (RTR) solar cells processed from polycrystalline feedstock showed maximum AMO efficiency of 5.6%. Solar cells from single crystalline feedstock showed slightly higher efficiency than those from polycrystalline feedstock, indicating maximum efficiency of about 6.6% with SiO<sub>2</sub> AR coating. Single crystalline control cells gave 11-12% AMO efficiencies demonstrating that the poor performance of the RTR solar was due to the low quality of material itself. Dendritic web solar cells from the standard process showed maximum AMO efficiency of 9.8% while efficiency of control solar cells were around 11-12%. Web solar cells from back surface field (BSF) process indicated maximum AMO efficiency of 10.8%. Some improvement in open circuit voltage was noticed from the BSF process. Small light spot scanning experiments were carried out on the solar cells from Wacker Silso, EFG, RTR, and dendritic web ribbons. Photoresponse results provided information on localized cell performance and grain size in polycrystalline material, and agreed quite well with the cell performance data, such as efficiency, minority carrier diffusion length, and spectral response. L.S.

N70-20403°/ Ross (Bernd) Associates, San Diego, Calif.  
 DEVELOPMENT OF ECONOMICAL IMPROVED THICK FILM  
 SOLAR CELL CONTACT Quarterly Report  
 Bernd Ross and David Mentley Jan. 1979 45 p refs Sponsored  
 by NASA Prepared for DOE and JPL  
 (Contract JPL-955164)  
 (NASA-CR-158358; DOE/JPL-955164-78/4; QR-1) Avail:  
 NTIS HC A03/MF A01 CSCL 10A

Materials were surveyed to provide candidates for an all metal electrode paste system. These consisted of a major constituent metal powder, a low melting metal powder suitable for a liquid phase sintering medium, and a powder material suitable as an etchant for silicon dioxide at sintering temperatures. By means of thermal gravimetric analysis a suitable binder was identified for low temperature fired inks. The all metal ink concept was first demonstrated with the silver system to avoid the problems of limited process windows encountered with base metal systems. A number of solid materials capable of selectively etching silicon dioxide at modest temperatures were identified. A paste with silver fluoride was screened onto N-type silicon with 5 ohm cm resistivity. The resulting contact pads had excellent adhesion but were not electrically ohmic. Metallurgically, these contacts have equal or better grain structure as commercial inks fired at the same temperatures. Author

N70-20407°/ West Virginia Univ., Morgantown.  
 SIMULATION OF FLUIDIZED BED COAL COMBUSTORS  
 Final Report  
 Ranga Rajan Feb. 1979 215 p refs  
 (Grant NSG-3134)  
 (NASA-CR-159529) Avail: NTIS HC A10/MF A01 CSCL 10B

The many deficiencies of previous work on simulation of fluidized bed combustion (FBC) processes are presented. An attempt is made to reduce these deficiencies, and to formulate a comprehensive FBC model taking into account the following elements: (1) devolatilization of coal and the subsequent combustion of volatiles and residual char; (2) sulfur dioxide capture by limestone; (3) NO<sub>x</sub> release and reduction of NO<sub>x</sub> by char; (4) attrition and elutriation of char and limestone; (5) bubble hydrodynamics; (6) solids mixing; (7) heat transfer between gas and solid, and solid and heat exchange surfaces; and (8) freeboard reactions. G.Y.

N70-20409°/ Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.  
 A FIXED TILT SOLAR COLLECTOR EMPLOYING RE-  
 VERBULATE VEE-TROUGH REFLECTORS AND EVALUATED  
 TUBE RECEIVERS FOR SOLAR HEATING AND COOLING  
 SYSTEMS  
 M. Kudrat Salcuk Oct. 1978 95 p refs  
 (Contract NAS7-100)  
 (NASA-CR-158420; DOE/JPL-1024-78/1; JPL-Pub-78-106)  
 Avail: NTIS HC A05/MF A01 CSCL 10A

The Vee-Trough/Evacuated Tube Collector (VTETC) was analyzed rigorously and various mathematical models were developed to calculate the optical performance of the vee-trough concentrators, and the quasi-steady state thermal performance of the evacuated tube receivers. Tests were run to verify the mathematical analyses. Back-silvered glass mirror, Alzak, Aluminized Teflon, and Kinglux (electropolished aluminum reflectors) were tested. Additional tests were run at temperatures ranging from 80 to 190 C (176-374 F). For the glass mirror reflectors, peak efficiencies, based on aperture area and operating temperatures of 125 C (257 F), were over 40%. Efficiencies of about 40% were observed at temperatures of 150 C (302 F) and 30% at 175 C (347 F). Test data for several days, predicted daily useful heats, and efficiency values are presented for a full year. These theoretical values were then compared with actual data points for the same temperature range. F.O.S.

N70-20401°/ Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.  
 THE PARABOLIC CONCENTRATING COLLECTOR: A  
 TUTORIAL  
 V. C. Truscello 1 Mar. 1979 47 p Prepared for DOE  
 (Contract NAS7-100)  
 (NASA-CR-158246; DOE/JPL-1080-79/1; JPL-Pub-79-7;



Rept-5102-107) Avail: NTIS HC A03/MF A01 CSCL 10A

A tutorial overview of point-focusing parabolic collectors is presented. Optical and thermal characteristics are discussed. Data representing typical achievable collector efficiencies are presented and the importance of balancing collector cost with concentrator quality is argued through the development of a figure of merit. Various types of two-axis tracking collectors are described. The Department of Energy program to develop these devices is briefly discussed, as are present and projected costs for these collectors. G.Y.

**N79-20402\*** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena. **THERMAL POWER SYSTEMS POINT-FOCUSING DISTRIBUTED RECEIVER TECHNOLOGY PROJECT. VOLUME 1: EXECUTIVE SUMMARY Annual Report**

John Lucas 15 Feb. 1979 31 p

(Contract NAS7-100)

(NASA-CR-158421; DOE/JPL-1080-7; JPL-Pub-79-1-Vol-1;

Rept-5104-26-Vol-1; JPL-5104-26) Avail: NTIS

HC A03/MF A01 CSCL 10A

Thermal or electrical power from the sun's radiated energy through Point-Focusing Distributed Receiver Technology is the goal of this project. The energy thus produced must be technically, as well as economically, competitive with other energy sources. This project is to support the industrial development of the required technology to achieve the above stated goal. Solar energy is concentrated by either a reflecting surface or a lense to a receiver where it is transferred to a working liquid or gas. Receiver temperatures are in the 1000 - 2000 F range. Conceptual design studies are expected to identify power conversion units with a viable place in the solar energy future. Rankine and Brayton cycle engines are under investigation. This report details the Jet Propulsion Laboratory's accomplishments with point-focusing technology in FY 1978. Author

**N79-20403\*** Colt, Inc. of Southern California, Rancho Mirage. **VERIFICATION TEST REPORT ON A SOLAR HEATING AND HOT WATER SYSTEM**

21 Jul. 1978 60 p Prepared for DOE

(Contract NAS8-32242)

(NASA-CR-161165) Avail: NTIS HC A04/MF A01 CSCL 10A

Information is provided on the development, qualification and acceptance verification of commercial solar heating and hot water systems and components. The verification includes the performances, the efficiencies and the various methods used, such as similarity, analysis, inspection, test, etc., that are applicable to satisfying the verification requirements. G.Y.

**N79-20404\*** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

**UTILITY OPERATIONAL EXPERIENCE ON THE NASA/DOE MOD-OA 200-KW WIND TURBINE**

J. C. Glasgow and W. H. Robbins 1979 30 p refs Presented at the 6th Energy Technol. Conf., Washington, D. C., 28-28 Feb. 1979; sponsored by Am. Gas. Assoc. - Gas. Res. Inst., Elec. Power Res. Inst., and Thomas Alva Edison Found. (Contract E(49-26)-1004)

(NASA-TM-79084; E9907; DOE/NASA/1004-79/1) Avail: NTIS HC A03/MF A01 CSCL 10B

The Mod-OA 200 wind turbine was designed and fabricated as part of the Federal Wind Energy Program. Early wind turbine operation and performance data were obtained while gaining initial experience in the operation of large, horizontal axis wind turbines in typical utility environments. The Mod-OA wind turbine was turned over to the Town of Clayton Light and Water Plant, Clayton, NM, for utility operation and on December 31, 1978, the machine had completed ten months of utility operation. The machine is described and the recent operational experience at Clayton, NM is documented. J.M.S.

**N79-20405\*** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala. **PERFORMANCE CHARACTERISTICS OF A 1.0 BY 3.7 METER FRESNEL LENS SOLAR CONCENTRATOR**

Leon J. Hastings and Steve L. Allums 12 Feb. 1979 25 p refs Backup document for AIAA Synoptic scheduled for publication in Journal of Energy, Mar. - Apr. 1979

(NASA-TM-78222; EP43-79-5) Avail: NTIS HC A02/MF A01 CSCL 10A

Line-focusing acrylic Fresnel lenses with application potential in the 200 to 370 C range were analytically and experimentally investigated. The measured solar concentration characteristics of a 1.8 by 3.7 m lens and its utilization in a solar collection mode are presented. A measured peak concentration ratio of 62 with 90 percent of the transmitted energy focused into a 5.0cm width was achieved. A peak concentration of 59 and a 90 percent target width of 4.3 cm were analytically computed. The experimental and analytical lens transmittance was 78 percent and 86 percent, respectively. The lens was also interfaced with a nonevacuated receiver assembly and operated in the collection mode. With a natural oxide absorber tube coating (alpha/epsilon = 0.79/0.10), the measured collection efficiency ranged from 43 percent to 200 C to 34 percent at 260 C. Efficiency improvements to the 40 to 50 percent range can be achieved with second generation lenses and higher performance absorptive coatings. Author

**N79-20407\*** Technical Report Services, Rocky River, Ohio. **EVALUATION OF URETHANE FOR FEASIBILITY OF USE IN WIND TURBINE BLADE DESIGN Final Report**

Seymour Lieblein, Robert S. Ross (Concept Development Inst., Hudson, Ohio), and Demeter G. Fertis (Akron Univ.) Apr. 1979 156 p

(NASA Order C-7653; Contract E(49-26)-1028)

(NASA-CR-159530; DOE/NASA/7653-79/1; TRS-101) Avail: NTIS HC A08/MF A01 CSCL 10B

A preliminary evaluation was conducted of the use of cast urethane as a possible material for low-cost blades for wind turbines. Specimen test data are presented for ultimate tensile strength, elastic modulus, flexural strain, creep, and fatigue properties of a number of urethane formulations. Data are also included for a large-scale urethane blade section composed of cast symmetrical half-profiles tested as a cantilever beam. Based on these results, an analysis was conducted of a full-scale blade design of cast urethane that meets the design specifications of the rotor blades for the NASA/DOE experimental 100-kW MOD-O wind turbine. Because of the low value of elastic modulus for urethane (around 457 000 psi), the design loads would have to be carried by metal reinforcement. Considerations for further evaluation are noted. Author

**N79-20408\*** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

**THERMAL STORAGE TECHNOLOGIES FOR SOLAR INDUSTRIAL PROCESS HEAT APPLICATIONS**

Larry H. Gordon 1979 19 p refs

(Contract EC-77-A-31-1034)

(NASA-TM-79130; DOE/NASA/1034-79/2; E-9970) Avail: NTIS HC A02/MF A01 CSCL 10A

The state-of-the-art of thermal storage subsystems for the intermediate and high temperature (100 C to 600 C) solar industrial process heat generation is presented. Primary emphasis is focused on buffering and diurnal storage as well as total energy transport. In addition, advanced thermal storage concepts which appear promising for future solar industrial process heat applications are discussed. J.M.S.

**N79-20409\*** Alabama Univ. in Huntsville. Kenneth E. Johnson Environmental Energy Center.

**COST ANALYSIS AND OPTIMIZATION STUDY FOR SOLAR HEATING AND COOLING SYSTEMS**

William L. Reid and Robert E. Shannon Jan. 1979 51 p refs (Contract NAS8-31293)

(NASA-CR-161200) Avail: NTIS HC A04/MF A01 CSCL 10A

Detailed cost analyses of two operational test sites which are a part of a solar energy development program are presented. Actual costs and potential cost improvements of new and retrofit solar space conditioning and hot water systems for single family



sized housing were studied. Operational test sites were used for evaluation as these projects are a part of the National Solar Heating and Cooling Demonstration Program. During the period involved in the initial cost analysis of the solar project, it became evident that a comparison of solar system costs with conventional heating, cooling, and hot water systems on a first cost basis was not sufficient for an overall view of life cycle costs for the consumer. J.M.S.

**N79-20500#** Argonne National Lab., Ill.  
**MDH BALANCE OF PLANT TECHNOLOGY PROJECT**  
**Quarterly Report, 1 Apr. 1978 - 30 Jun. 1978**

Michael Petrick, Kenneth E. Tempelmeyer, and Terry R. Johnson  
 Aug. 1978 62 p refs  
 (Contract W-31-109-eng-38)  
 (ANL-MHD-78-7; QR-2) Avail: NTIS HC A04/MF A01

The design and operation of the heat and seed recovery systems downstream of channel-diffuser and to the seed regeneration processes were studied. Engineering data needed to design components in MHD prototype and demonstration facilities were obtained. Activities discussed include: (1) preparation of a national program plan for heat and seed recovery systems; (2) analytical modeling of the heat transfer and seed-slag separation processes in the radiant boiler; (3) modeling of the formation growth, and behavior of slag and seed particles in the combustion gas stream; (4) studies of the thermochemistry of seed-slag systems; (5) investigations of ceramic and metallic materials for use in the downstream gas systems; (6) small-scale engineering studies of seed-slag deposition; (7) design and construction of a 2-MW experimental facility for investigations pertaining to the downstream gas system, and (8) evaluations of seed regeneration processes. J.M.S.

**N79-20502#** Brookhaven National Lab., Upton, N. Y.  
**METHODOLOGY FOR MODELING GEOTHERMAL DISTRICT HEATING FOR RESIDENTIAL MARKETS**

John Karkheck and Raymond G. Tessmer, Jr. Aug. 1978 26 p refs  
 (Contract EY-76-C-02-0016)  
 (BNL-50905) Avail: NTIS HC A03/MF A01

Methodology is presented for modeling geothermal district heat service and for evaluating the economic market potential for such nonelectrical utilization of the geothermal resource. It is based upon accurate determination of the heating demand and its spatial and temporal profile in each potential market, determination of the cost to provide such service, and correlation of markets and resource sites. Two components of the model are discussed. The residential demand submodel and data base projects heating demand densities and temporal profiles along with building service modifications and costs. The service submodel and data base design and costs a subtransmission and distribution network, and it evaluates operating losses at design conditions. Author

**N79-20503#** Argonne National Lab., Ill. Engineering Div.  
**PARAMETRIC STUDY OF THE PERFORMANCE OF A CDIF 1-B COAL-FIRED MHD GENERATOR**

R. K. Ahluwalia, H. K. Geyer, and E. D. Doss Feb. 1979 51 p refs  
 (Contract W-31-109-eng-38)  
 (ANL-MHD-79-3) Avail: NTIS HC A02/MF A01

A comprehensive study is conducted into the analysis of a coal-fired Component Development and Integration Facility (CDIF) 1-B channel performance to simulate the characteristics of the reference Engineering Test Facility (ETF) channel. The performance criteria are established by careful review of the role played by the gas dynamic and electrical variables in determining channel behavior. On the basis of this review, a constant-velocity subsonic channel operating at nominal combustor pressure of 5.4 atm (0.54 MPa) is selected. The channel loading is selected to obtain a maximum Hall field of 2.4 kV/m and maximum transverse current density of 1.1 A/sq cm. Author

**N79-20504#** Battelle Pacific Northwest Labs., Richland, Wash.  
**DEVELOPMENT, CHARACTERIZATION AND EVALUATION OF MATERIALS FOR OPEN CYCLE MHD Quarterly Report, period ending Jun. 1978**

J. Lambert Bates, D. D. Marchant, and J. L. Daniel Oct. 1978 65 p refs  
 (Contract EY-76-C-06-1830)  
 (PNL-2004-9) Avail: NTIS HC A04/MF A01

The program is directed toward the development and characterization of high temperature ceramics for open-cycle, coal-fired MHD power generators. The current activities are directed to electrode and insulator materials, and include: (1) determination of the effects of alkali seed on the behavior of ceramics in a dc electric field; (2) development and testing of improved high temperature ceramic electrodes and insulators with controlled composition, microstructure, and properties; and (3) characterization and evaluation of materials utilized in channels being tested for MHD power generator development. G.Y.

**N79-20505#** United Technologies Corp., South Windsor, Conn.  
**Power Systems Div.**

**VENTURE ANALYSIS CASE STUDY FOR ON-SITE FUEL CELL ENERGY SYSTEMS Final Report**

P. Bolan, P. Farris, and S. Folstad 31 Jul. 1978 76 p  
 (Contract EX-77-C-01-2684)  
 (FCR-0783-Vol-1) Avail: NTIS HC A05/MF A01

The benefits and the consequences of commercialization of on-site fuel cell energy systems were evaluated. In the business venture selected for this case study, gas utility companies would own and operate efficient, clean, quiet fuel cell power plants on the customer's premises and provide electrical and thermal energy services to the consumer upon demand. For each building, an integrated energy system is assumed where the fuel cell provides all of the electricity for lights and equipment; fuel cell heat is recovered for space and water heating; and fuel cell driven heat pumps, utilizing replenishable energy from the surroundings, provide space heating and cooling. Very high fuel utilization efficiencies, in the neighborhood of 100 percent, were measured in testing this type system. Success of this energy service venture depends upon gas company marketing and servicing efforts, and upon the manufacturer supplying reliable and economical fuel cell power plants. J.M.S.

**N79-20506#** Battelle Pacific Northwest Labs., Richland, Wash.  
**WIND DIRECTION CHANGE CRITERIA FOR WIND TURBINE DESIGN**

W. C. Cliff Jan. 1979 17 p refs  
 (Contract EY-76-C-06-1830)  
 (PNL-2531) Avail: NTIS HC A02/MF A01

A method is presented for estimating the root mean square (rms) value of the wind direction change,  $\Delta\theta$  (tau) =  $\theta(\tau + \tau) - \theta(\tau)$ , that occurs over the swept area of wind turbine rotor systems. An equation is also given for the rms value of the wind direction change that occurs at a single point in space, i.e., a direction change that a wind vane would measure. Equations are given for calculating the expected number of wind direction changes, larger than an arbitrary value, that will occur in 1 hr as well as the expected number that will occur during the design life of a wind turbine. The equations are developed using a small angle approximation and are, therefore, considered appropriate for wind direction changes of less than 30 degrees. The equations are based upon neutral atmospheric boundary-layer conditions. G.Y.

**N79-20507#** Argonne National Lab., Ill.  
**TECHNICAL SUPPORT FOR OPEN-CYCLE MHD PROGRAM**  
**Progress Report, 1 Jan. - 31 Mar. 1978**

J. Patten, ed. May 1978 104 p refs  
 (Contract W-31-109-eng-38)  
 (ANL-MHD-78-8) Avail: NTIS HC A06/MF A01

The support program for open-cycle MHD (magnetohydrodynamic) at Argonne National Lab is developing the analytical tools needed to investigate the performance of the major components in the combined-cycle MHD/steam power system. The analytical effort is centered on the primary components of the system that are unique to MHD and also on the integration of these analytical representations into a model of the entire power producing system. The present project activities include modeling of the combustor, MHD channel, slag separator, and the high-temperature air preheater. These models are combined into

a complete system model, which is at present capable of carrying out optimizations of the entire system on either thermodynamic efficiency or with less confidence, cost of electrical power.  
Author

**N79-20303#** Edgerton, Germeshausen and Grier, Inc., Idaho Falls, Idaho.

**MEASUREMENT AND CONTROL TECHNIQUES IN GEOTHERMAL POWER PLANTS**

J. F. Whitbeck, R. H. Dart, J. D. Miller, and D. R. Brewer (Rogers Engineering) Jan. 1979 80 p refs  
(Contract EY-76-C-07-1570)

(TREE-1312) Avail: NTIS HC A05/MF A01

The background and source material used in preparing the chapter of the Geothermal Source Book on instrumentation, measurement, and control techniques is provided. Included are detailed examples of instrumentation and control techniques currently being used in geothermal power plants. In addition, the basic guidelines and unique characteristics of instrumentation and control in geothermal systems, are presented. G.Y.

**N79-20303#** Department of Energy, Washington, D. C. Office of Energy Use Analysis.

**MEASURING ENERGY CONSERVATION**

Dec. 1978 44 p refs

(DOE/EIA-0103/18; TM/EU/79-06)

Avail: NTIS

HC A03/MF A01

The meaning of energy conservation is briefly examined and alternative methods for measuring energy conservation are described. Current methods employed to forecast the impacts of energy conservation programs are included along with energy models, capable of analyzing the impacts of energy conservation legislation or the use of more energy-efficient equipment. J.M.S.

**N79-20310#** TRW Defense and Space Systems Group, Redondo Beach, Calif.

**HIGH PRESSURE MHD COAL COMBUSTORS INVESTIGATION** Quarterly Technical Progress Report, 15 May - 15 Aug. 1978

John A. Hardgrove 15 Aug. 1978 52 p

(Contract ET-78-C-01-2706)

(FE-2706-08; QTPR-2) Avail: NTIS HC A04/MF A01

Progress during this reporting period included the following: Assembled and checked out the combustor and instrumentation; completed design of the average conductivity section; conducted over-drying tests of coal in 50-lb paper bags; conducted 32 combustor test firings; investigated the effects of first stage stoichiometry and coal injector configuration and position; tested a technique for mechanically retaining slag on the combustor walls; set up and tested the seed injection system; and used the breadboard sodium D-line temperature measuring equipment for plasma thermal characterization during three coal firing tests. G.Y.

**N79-20311#** Massachusetts Inst. of Tech., Cambridge. Energy Lab.

**CRITICAL CONTRIBUTIONS IN MHD POWER GENERATION** Quarterly Technical Progress Report, 1 Dec. 1977

28 Feb. 1978

J. F. Louis Mar. 1978 179 p refs

(Contract EF-76-C-01-2215)

(FE-2215-11) Avail: NTIS HC A09/MF A01

During the last year work was focused primarily on electrode and insulator systems for the generator. The major results reported were the engineering data for the spiral module. The current thrust is on superhot wall materials based on zirconates. New and important results from the laboratory measurements were translated into working electrode modules. Detailed description of technical progress is given for the following tasks: (1) electrode module materials evaluation; (2) electrode module development; (3) coal combustion studies; (4) critical phenomena in MHD generators; (5) studies in a disk generator; (6) MHD component modeling; (7) MHD generator modeling; (8) participation in US USSR cooperative MHD program; and (9) Dept. of Energy/MHD Program support. G.Y.

**N79-20312#** Stanford Univ., Calif.

**AXIAL FIELD LIMITATIONS IN MHD GENERATORS**

William C. Unkel Apr. 1978 392 p refs

(Contract EX-76-C-01-2341)

(FE-2341-8) Avail: NTIS HC A17/MF A01

The results of an investigation of axial field breakdown in nonslagging wall, combustion driven MHD generators are presented. Breakdown was characterized by a rapid decline in axial voltage and a change in the mode of current transport from a relatively diffuse mode to a highly constricted and extremely destructive mode. Cinematographic records demonstrated that breakdown could be initiated in the plasma or in the interelectrode insulator. Plasma initiated and insulator initiated breakdown resulted only when a threshold voltage was exceeded. For the electrode wall configuration studied, the threshold voltage for plasma initiated breakdown was significantly higher than the threshold voltage for insulator initiated breakdown. Electro-thermal instability was responsible for the behavior observed in the experiments. A computer model was developed to predict the nonbreakdown and incipient breakdown behavior for the interelectrode insulator region for the simplified configuration. Author

**N79-20313#** National Aeronautics and Space Administration. Pasadena Office, Calif.

**AN IMPROVED SOLAR ENERGY RECEIVER FOR A STIRLING ENGINE** Patent Application

M. Kudret Selcuk, inventor (to NASA) (JPL) Filed 6 Apr. 1979 12 p

(Contract NAS7-100)

(NASA-Case-NPO-14619-1; US-Patent-Appl-SN-027559) Avail: NTIS HC A02/MF A01 CSCL 10A

Damage to a Stirling engine is prevented by using a solar receiver of separable configuration to reduce solar flux density in order to protect the heat exchanger contained within the receiver. A solar energy receiver includes a separable endless wall formed of a ceramic material in which a cavity of a substantially cylindrical configuration is defined for entrapping solar flux. An acceptance aperture admits a concentrated beam of solar energy to the cavity. The wall is characterized by at least one pair of contiguously related segments separated by lines of cleavage intercepting the aperture. At least one of the segments is supported for pivotal displacement. A thermalresponsive actuator is adapted to respond to excessive temperatures within the cavity for initiating pivotal displacement of one segment, so that thermal flux is permitted to escape from the cavity. NASA

**N79-20314#** Department of Energy, Washington, D. C. ENVIRONMENTAL IMPACT DETERMINATION OF ACTION TO BE TAKEN UNDER THE ENERGY SUPPLY AND ENVIRONMENTAL COORDINATION ACT FOR POWER PLANTS 1, 2, 3, AND 4, PORTSMOUTH GENERATING STATION, PORTSMOUTH, VIRGINIA

Mar. 1978 119 p refs

(DOE/EA-0033) Avail: NTIS HC A06/MF A01

An environmental assessment of the proposed Notice of Effectiveness is given to make effective the prohibition order prohibiting burning of gas or oil as the primary energy source at the Portsmouth Generating Station power plants (Virginia Electric Power Company). A description of the facility and its surroundings, along with alternative generating station operations are discussed. Conversion effects on: air quality; land use/solid wastes; water quality and uses; ecosystems; and esthetics, are also discussed. G.Y.

**N79-20315#** General Electric Co., Philadelphia, Pa. Space Div.

**MHD-ETF PROGRAM. VOLUME 1: EXECUTIVE SUMMARY**

Final Report, 4 Jan. 1977 - 4 Mar. 1978

Mar. 1978 56 p

(Contract EF-77-C-01-2613)

(FE-2613-6-Vol-1) Avail: NTIS HC A04/MF A01

A conceptual design study was performed to establish a reference design for a magnetohydrodynamic engineering test facility (MHD-ETF). Alternative conceptual designs were developed to the point where an evaluation and selection of a

preferred concept could be made. The preferred conceptual design was then updated to provide an ETF reference design. Capital cost estimates and operating and maintenance cost estimates were then prepared. Critical advanced technology development requirements were identified. The ETF system configuration is a 250 MWt size, coal fired, MHD/Steam combined cycle plant.

Author

**N79-20516#** General Electric Co., Philadelphia, Pa. Space Div.  
**MHD-ETF PROGRAM. VOLUME 2A, PARTS 1 AND 2: REFERENCE DESIGN DESCRIPTION** Final Report, 4 Jan. 1977

Mar. 1978 238 p refs

(Contract EF-77-C-01-2613)

(FE-2613-6-Vol-2A) Avail: NTIS HC A11/MF A01

Volume 2A, Parts 1 and 2, of a multivolume report is given. Part 1 gives a system design description and rationale and discusses the following: groundrules, size and flexibility; degree of slag rejection; NOx prediction and its influence on the system; supercritical vs. subcritical boiler; system configuration (and with bottom only); performance analysis; system operation; and reliability and maintainability. Part 2 gives the plant design description and includes discussion on the following: site; plant buildings, structures and improvements; boiler plant; steam turbine (generator and auxiliaries); accessory electrical equipment (production plant); miscellaneous power plant equipment; magnetohydrodynamic cycle equipment; research equipment and centralized instrumentation and control equipment; and transmission plant.

G.Y.

**N79-20517#** Montana Energy and MHB Research and Development Inst., Inc., Butte.

**MHD POWER GENERATION: RESEARCH, DEVELOPMENT AND ENGINEERING** Quarterly Progress Report, Jan. - Mar. 1978

Mar. 1978 259 p refs

(Contract EF-77-C-01-2524)

(FE-2524-8) Avail: NTIS HC A13/MF A01

A special compilation of several task reports under contract to the U. S. Department of Energy is presented. Summarizing the work accomplished from January to March 1978, the reports cover the MERDI (Montana Energy and MHD Research and Development Institute) Materials Evaluation task and the tasks being performed by the Montana College of Mineral Science and Technology and Montana State University.

G.Y.

**N79-20518#** Montana Energy and MHB Research and Development Inst., Inc., Butte.

**MHD POWER GENERATION: RESEARCH, DEVELOPMENT AND ENGINEERING** Quarterly Progress Report, Apr. - Jun. 1978

Jun. 1978 209 p refs

(Contract ET-78-C-01-3087)

(FE-3087-2) Avail: NTIS HC A10/MF A01

The Montana Energy and MHD Research and Development Institute (MERDI) was established in Butte, Montana in 1974 to develop methods for conserving western energy sources and to carry out supporting science and technology tasks for the national magnetohydrodynamic (MHD) program. Under contract to the U. S. Department of Energy, these tasks were divided among researchers at MERDI, the Montana Colleges of Mineral Science and Technology (MCMST), and Montana State University (MSU). The work accomplished by MERDI, MCMST, and MSU from April through June 1978 are summarized.

G.Y.

**N79-20519#** North Carolina Science and Technology Research Center, Research Triangle Park.

**AN ANALYTICAL INVESTIGATION OF THE PERFORMANCE OF SOLAR COLLECTORS AS NIGHTTIME HEAT RADIATORS IN AIRCONDITIONING CYCLES** Final Report

Clay B. Jones and Frederick O. Smetana Mar. 1979 82 p refs

(Contract NAS1-14208)

(NASA-CR-3111) Avail: NTIS HC A04/MF A01 CSCL 10A

It was found that if the upper and lower ends of a collector were opened, large free convection currents may be set up

between the collector surface and the cover glass(es) which can result in appreciable heat rejection. If the collector is so designed that both plates surfaces are exposed to convection currents when the upper and lower ends of the collector enclosure are opened, the heat rejection rate is 300 watts sq m when the plate is 13 C above ambient. This is sufficient to permit a collector array designed to provide 100 percent of the heating needs of a home to reject the accumulated daily air conditioning load during the course of a summer night. This also permits the overall energy requirements for cooling to be reduced by at least 15 percent and shift the load on the utility entirely to the nighttime hours.

Author

**N79-20522#** Army Construction Engineering Research Lab., Champaign, Ill.

**DESIGN OF SOLAR HEATING AND COOLING SYSTEMS** Final Report

David M. Joncich, Donald James Leverenz, Douglas C. Hittle, and George N. Walton Oct. 1978 59 p refs

(DA Proj. 4A7-62731-AT-41)

(AD-A062719; CERL-TR-E-139)

Avail: NTIS

HC A04/MF A01 CSCL 13/1

This report presents a method for making an energy and an economic cost/benefit analysis of solar energy systems. A graphical method is presented for evaluating the performance of solar domestic hot water system, solar heating systems, and solar heating and cooling systems. Methods for selecting the optimum collector area based on benefit-to-cost ratio and for systematically making detailed design calculations using the Building Loads Analysis and System Thermodynamics (BLAST) computer simulation program are also presented. Practical considerations for solar system designs are discussed. The methods presented provide the required accuracy for both initial evaluations and final design calculations. Examples are provided throughout the text to aid in using the methods described.

Author (GRA)

**N79-20524#** National Bureau of Standards, Washington, D. C. Building Economics and Regulatory Technology Div.

**LABORATORIES TECHNICALLY QUALIFIED TO TEST SOLAR COLLECTORS IN ACCORDANCE WITH ASHRAE STANDARD 93-77: A SUMMARY REPORT** Final Report

William J. Niessing Nov. 1978 40 p

(Contract EA-77-A-01-6010)

(PB-289729/6; NBSIR-78-1535)

Avail: NTIS

HC A03/MF A01 CSCL 14B

The procedures used by ARI Foundation Inc. and the results of their evaluation are described. The laboratories evaluated as qualified to test solar collectors in accordance with American Society of Heating, Refrigerating and Air-Conditioning Engineers Standard 93-77 are listed.

GRA

**N79-20525#** NATO Committee on the Challenges of Modern Society, Brussels (Belgium).

**SOLAR ENERGY PILOT STUDY** Final Report

Oct. 1978 100 p Prepared by Maryland Univ., College Park (Contract EY-76-S-05-4908)

(PB-289380/8; NATO/CCMS-83; UMD-4908-13) Avail: NTIS

HC A05/MF A01 CSCL 13A

The CCMS Solar Energy Pilot Study was established in 1973 with the objective of encouraging the cost-effective and practical application of solar energy to heating and cooling in residential, commercial, industrial, agricultural, and public buildings. The scope of the pilot study has been the exchange of information on: (1) national solar heating and cooling programs; (2) solar heating and cooling experiments, with emphasis on system performance data; and (3) specialized regional applications of solar heating and cooling. The various elements of this multilateral cooperative program are discussed.

GRA

**N79-20526#** Illinois Valley Economic Development Corp., Carlinville.

**SOLAR SPACE HEATERS FOR LOW-INCOME FAMILIES**

Roger Fenton and Patti Donahue Sep. 1978 29 p refs Sponsored by Illinois Inst. of Natural Resources.

(PB-289244/6; ILDOE-78/09)

Avail: NTIS

HC A03/MF A01 CSCL 13A

The publication is a manual designed to guide individuals in the construction and installation of a low-cost window-box solar collector. Included are explanations of solar collector fundamentals, lists of construction and installation materials and tools, step-by-step procedures for building and installing a unit and an extensive bibliography of information on home weatherization and solar energy use. GRA

**N79-20727#** Syracuse Research Corp., N. Y.  
**HEALTH EFFECTS ASSOCIATED WITH DIESEL EXHAUST EMISSIONS, LITERATURE REVIEW AND EVALUATION**  
 Joseph Santodonato, Dipak Basu, and Philip Howard Nov. 1978 165 p refs  
 (Contract EPA-68-02-2800)  
 (PB-289817/9; EPA-600/1-78-063) Avail: NTIS  
 HC A08/MF A01 CSCL 06T

Engineering tests have shown a significant improvement in fuel economy in light duty vehicles equipped with diesel engines versus those equipped with gasoline engines. Automobile manufacturers are considering a major program for conversion to diesel engines in the automobile fleet by 1985. Available studies show rather large differences in emissions from diesel engine exhausts as opposed to gasoline engine exhaust. An assessment of the current state of knowledge regarding the health effects from diesel exhaust emissions, and the identification of major research needs, are important factors. In order to accomplish this objective, the following information on diesel emissions was reviewed: physical and chemical characteristics; biological effects in animals and man; epidemiologic studies; knowledge gaps; and research needs. GRA

**N79-20927#** Brookhaven National Lab., Upton, N. Y.  
**ECONOMIC IMPACTS OF A TRANSITION TO HIGHER OIL PRICES**  
 Raymond G. Tessmer, Jr., Steven C. Carhart, and William Marcuse Jun. 1978 63 p refs  
 (Contract EY-76-C-02-0016)  
 (BNL-50871) Avail: NTIS HC A04/MF A01

Economic impacts of sharply higher oil and gas prices in the eighties are estimated using a combination of optimization and input-output models. A 1985 base case is compared with a high case in which crude oil and crude natural gas are, respectively, 2.1 and 1.4 times as expensive as in the base case. Impacts examined include delivered energy prices and demands, resource consumption, emission levels and costs, aggregate and compositional changes in Gross National Product, balance of payments, output, employment, and sectoral prices. Methodology is developed for linking models in both quantity and price space for energy service - specific fuel demands. A set of energy demand elasticities is derived which is consistent between alternative 1985 cases and between the 1985 cases and an historical year (1967). A framework and methodology are also presented for allocating portions of the DOE conservation budget according to broad policy objectives and allocation rules. Author

**N79-20928** Committee of the Whole House on the State of the Union (U. S. House).  
**AUTHORIZING APPROPRIATIONS TO THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION**  
 Washington GPO 1979 237 p refs Rept. together with additional views to accompany H.R. 1786 from the Comm. on Sci. and Technol., 96th Congr., 1st Sess., 19 Mar. 1979  
 (H-Rept-96-52; GPO-41-646) Avail: US Capital, House Document Room

Increases and reductions in NASA's request for funding to support research and development, construction of facilities, and program management are justified in an analysis of H.R. 1786 which is recommended for passage. A.R.H.

**N79-21075#** Ford Motor Co., Dearborn, Mich. Research Staff.  
**EVALUATION OF CERAMICS FOR STATOR APPLICATION: GAS TURBINE ENGINE REPORT** Progress Report, 1 Feb. 1978 - 31 Jul. 1978

W. Trela and P. H. Havstad Nov. 1978 36 p refs Prepared for DOE  
 (Contract DEN-3-00019)  
 (NASA-CR-159533; DOE/NASA/0019-78/1) Avail: NTIS  
 HC A03/MF A01 CSCL 21E

Current ceramic materials, component fabrication processes, and reliability prediction capability for ceramic stators in an automotive gas turbine engine environment are assessed. Simulated engine duty cycle testing of stators conducted at temperatures up to 1093 C is discussed. Materials evaluated are SiC and Si<sub>3</sub>N<sub>4</sub> fabricated from two near-net-shape processes: slip casting and injection molding. Stators for durability cycle evaluation and test specimens for material property characterization, and reliability prediction model prepared to predict stator performance in the simulated engine environment are considered. The status and description of the work performed for the reliability prediction modeling, stator fabrication, material property characterization, and ceramic stator evaluation efforts are reported. J.M.S.

**N79-21167#** National Bureau of Standards, Washington, D. C.  
**TEST PROCEDURES FOR THE DETERMINATION OF THE GROSS CALORIC VALUE OF REFUSE AND REFUSE-DERIVED FUELS BY OXYGEN BOMB CALORIMETRY: SUMMARY OF THE 1977 FISCAL YEAR RESULTS** Interim Report, 1 Apr. - 30 Sep. 1977  
 D. R. Kirklin, D. J. Mitchell, J. Cohen, E. S. Domalski, and S. Abramowitz Dec. 1978 36 p refs Sponsored in part by DOE and EPA  
 (PB-290160/1; NBSIR-78-1494) Avail: NTIS  
 HC A03/MF A01 CSCL 07D

Procedures used for coke and coal were modified to determine the gross caloric values (moisture and ash-free basis) for refuse derived from fuels provided by two manufacturers. The values obtained for one fuel ranged from 24.51 to 25.20 MJ kg (10539 to 10835 Btu lb) with a standard deviation of 0.8%. Values of the other product ranged from 21.93 to 22.16 MJ kg (9427 to 9528 Btu lb) with a standard deviation of 0.4%. Results of 23 laboratory samples are presented at various stages of sample preparation which were derived from single field samples from each of the two sources. Calorimetric results based on an equilibrated laboratory sample are presented along with some semi-quantitative spectrochemical results. The results indicate that the techniques of oxygen bomb calorimetry can be successfully applied to a non-homogeneous refuse stream after considerable processing to prepare a homogeneous refuse-derived fuel. GRA

**N79-21215** Notre Dame Univ., Ind.  
**CATALYTIC EFFECT OF Ni AND K<sub>2</sub>CO<sub>3</sub> IN THE GASIFICATION OF CARBON AND COAL** Ph.D. Thesis  
 Guillermo Leon GuzmanR 1979 216 p  
 Avail: Univ. Microfilms Order No. 7908378

The catalytic effect of nickel and K<sub>2</sub>CO<sub>3</sub> on the gasification of activated carbon and Illinois Number 6 coal was studied at atmospheric pressure and temperatures between 500 to 927 C, using a Cahn RG electrobalance. Nickel was a very active catalyst in the gasification of activated carbon, producing CH<sub>4</sub> in hydrogasification and mainly CO<sub>2</sub> and CO in steam gasification. In coal, nickel exhibited very low activity, probably due to sulphur poisoning. The catalytic effect of K<sub>2</sub>CO<sub>3</sub> on the steam gasification of activated carbon and coal was investigated. K<sub>2</sub>CO<sub>3</sub> is a good catalyst in both carbon samples but its activity was less than the activity observed for nickel in activated carbon. Unlike nickel, K<sub>2</sub>CO<sub>3</sub> is not deactivated by the sulphur content of the coal and can be recovered from the remaining ashes. Dissert. Abstr.

**N79-21217#** National Aeronautics and Space Administration, Washington, D. C.  
**DEPENDENCE OF THE POUR POINT OF DIESEL FUELS ON THE PROPERTIES OF THE INITIAL COMPONENTS**  
 V. M. Ostashov and S. A. Bobrovskiy Apr. 1979 8 p refs Transl. into English of 'Zavisimost' Temperatury Zastyvaniya Dizelnykh Toplivo ot Svoystv Iskhodnykh Komponentov', Rept. no. 87 Moskovskiy Inst. Neftekhimicheskoy i Gasovoy Promyshlennosti, Moscow, 1971 p 124-126 Transl. by Kanner (Leo) Associates, Redwood City, Calif.  
 (Contract NASw-3199)  
 (NASA-TM-75424) Avail: NTIS HC A02/MF A01 CSCL 21D

An analytical expression is obtained for the dependence of the pour point of diesel fuels on the pour point and weight relationship of the initial components. For determining the pour point of a multicomponent fuel mixture, it is assumed that the mixture of two components has the pour point of a separate equivalent component, then calculating the pour point of this equivalent component mixed with a third component, etc. Author

**N79-21223#** National Technical Information Service, Springfield, Va.

**SYNTHETIC FUELS: METHANE. CITATIONS FROM THE ENGINEERING INDEX DATA BASE Progress Report, 1970 - Jan. 1979**

Diane M. Cavagnaro Feb. 1979 269 p Supersedes NTIS/PS-78/0054 (NTIS/PS-79/0030/1; NTIS/PS-78/0054). Avail: NTIS HC \$28.00/MF \$28.00 CSCL 210

The production of methane is discussed in this bibliography containing worldwide citations. The reports pertain to the manufacturing processes, equipment used, performance, economics, and combustion technology. Many of the studies cover the production of methane from wastes, especially agricultural wastes. GRA

**N79-21224#** Battelle Columbus Labs., Ohio.

**PRELIMINARY ENVIRONMENTAL ASSESSMENT OF BIOMASS CONVERSION TO SYNTHETIC FUELS Report for Jul. 1978 - Dec. 1978**

S. T. DiNovo, W. E. Ballantyne, L. M. Curran, W. C. Baytos, and K. M. Duke Oct. 1978 366 p refs (Contract EPA-68-02-1323) (PB-289775/9; EPA-600/7-78-204) Avail: NTIS HC A16/MF A01 CSCL 210

A preliminary evaluation of biomass production and conversion technologies, and their associated environmental consequences is presented. Five categories of biomass production were considered in detail. Thermochemical and biochemical technology were considered for conversion processes. Regionalized scenarios were prepared using commercial scale plants processing appropriate regionalized feedstock. Most processes use heterogeneous solid waste as a feed stock which are believed to pose more severe control requirements for emissions and effluents than other biomass feedstocks. The environmental and socio-economic effects of locating large conversion plants in rural environments need to be studied. GRA

**N79-21233#** Coast Guard, Washington, D.C. Merchant Marine Safety.

**LIQUEFIED NATURAL GAS SAFETY RESEARCH OVERVIEW Final Report**

Alan L. Schneider Dec. 1978 72 p refs Presented at the LNG Terminal and Safety Symp., San Diego, Calif., 12-13 Oct. 1978; sponsored by the Am. Gas Assoc. and the Cryogenic Soc. of Am.

(AD-A063714) Avail: NTIS HC A04/MF A01 CSCL 21/4

Liquefied Natural Gas (LNG) is a growing factor in the United States energy supply situation, both for periods of high demand, peak shaving, and for daily supply (base load). Safety has been a major issue in its acceptance by the public, the government, and industry. Perhaps because of this, industry and government have undertaken programs of research, development, testing, and evaluation that are more extensive than those for most other new hazardous materials. This paper records the experimental and theoretical work performed with the goal of increasing LNG safety, and has been organized in fourteen divisions: land storage tank studies, rollover, dispersion from spills on land, land spill fire studies, land spill fire protection, ship studies, flameless explosion, dispersion from spills on water, underwater releases, water spill fire studies, vapor cloud deflagration, vapor cloud detonation, physical properties, and gelation. Examining the record of the LNG research effort leads inevitably to the conclusion that there is a basic understanding of the material, sufficient to design, operate, and regulate LNG transportation and storage.

Author (GRA)

**N79-21235#** National Inst. of Building Sciences, Washington, D. C. Building Economics and Regulatory Technology Div.

**SOLAR BUILDING REGULATORY STUDY, VOLUME 1 Final Report**

Nov. 1978 93 p Sponsored in part by NBS (Contract EA-77-A-01-6010) (PB-289823/7; NBS-GCR-78-141-1-Vol-1) Avail: NTIS HC A05/MF A01 CSCL 13A

The results of a project oriented toward obtaining the views of organizations representing diversified interests within the building community are documented. The need for a solar regulatory system, and the form such a system should take if indeed a solar regulatory system were recommended are discussed. GRA

**N79-21248#** Williston, McNeil and Associates, Lakewood, Colo. **A TIME DOMAIN SURVEY OF THE LOS ALAMOS REGION, NEW MEXICO**

Los Alamos, N. Mex. LASL Jan. 1979 51 p ref (Contract W-7405-eng-36) (LA-7657-MS) Avail: NTIS HC A04/MF A01

A time domain electromagnetic sounding survey of the region surrounding the city of Los Alamos, New Mexico was carried out. The results show that a linear through, trending northeast-southwest runs beneath the city. The southern boundary is somewhat to the south of the city, the northern boundary was not established. The geoelectric section consists of three layers and the total thickness of the section is in excess of 3,000 m. The resistivities of the second layer are as low as 2.5 ohms m. If the salinities are in the region of 7,000 ppm, the resistivities could indicate that water with a temperature of 150 C may be found at a depth of 3,000 m. Author

**N79-21309#** Biphase Energy Systems, Inc., Santa Monica, Calif. **DEMONSTRATION OF A ROTARY SEPARATOR FOR TWO-PHASE BRINE AND STEAM FLOWS Final Report**

Donald J. Cerini Jan. 1978 122 p refs (Contract EY-76-C-03-1228) (TID-28519) Avail: NTIS HC A06/MF A01

The application of a two-phase rotary separator for geothermal energy conversion was demonstrated. The system tested consisted of the major components of a total flow rotary separator/turbine conversion system. A nozzle converted the brine wellhead enthalpy to two-phase flow kinetic by impinging the nozzle flow tangentially on the inside of the separator. The flow was subjected to the high centrifugal force field in the separator. This caused the liquid phase to collect as a film on the separator drum with very little energy loss. The steam was allowed to flow radially inward to the central steam discharge. Potable water was obtained by condensing the steam exhaust. The brine collection system converted the liquid film kinetic energy to static pressure head. Application of the rotary separator/turbine to a two-stage flash steam system showed a calculated power increase of 18%. Author

**N79-21310#** Stanford Univ., Calif. **INSULATING WALL BOUNDARY LAYER IN A FARADAY MHD GENERATOR**

Roy R. Rankin Apr. 1978 129 p refs (Contract EX-76-C-01-2341) (FE-23417) Avail: NTIS HC A07/MF A01

Experimental and analytical investigation was undertaken of the insulating wall boundary layer in a Faraday MHD generator. Insulating wall boundary layers show that modifications due to (MHD) effects have significant influence on the insulating wall friction and heat transfer in Faraday MHD generators. Modified flow (Hartmann Flow) is evidenced by an alteration of the velocity profile, due to the variation of the  $J \times B$  force across the channel in the magnetic field direction. The nonuniform current distribution is related to variations in both the velocity and the electrical conductivity across the channel. The analytic model involved computerized solution, using finite difference techniques, of the momentum, energy, and electrical equations, including MHD effects for the turbulent insulating wall boundary layer. The turbulence model used, was the mixing length theory which was modified to include turbulence damping. Variable, equilibrium properties were employed producing a coupling between the

momentum, energy, and electrical equations resulting in extended Hartmann flow. The experimental study consisted of the measurement of the velocity profile at the center of the insulating wall in an MHD generator using a laser anemometer. L.P.

**N79-21334\*** Lockheed Missiles and Space Co., Palo Alto, Calif. Research Lab.

**LASER POWER CONVERSION SYSTEM ANALYSIS, VOLUME 1 Final Report, 26 Sep. 1977 - 26 Sep. 1978**

W. S. Jones, L. L. Morgan, J. B. Forsyth, and J. P. Skratt  
15 Mar. 1979 109 p refs

(Contract NAS3-21137)

(NASA-CR-159523-Vol-1; LMSC-D673466-Vol-1) Avail: NTIS HC A06/MF A01 CSCL 20E

The orbit-to-orbit laser energy conversion system analysis established a mission model of satellites with various orbital parameters and average electrical power requirements ranging from 1 to 300 kW. The system analysis evaluated various conversion techniques, power system deployment parameters, power system electrical supplies and other critical supplies and other critical subsystems relative to various combinations of the mission model. The analysis shows that the laser power system would not be competitive with current satellite power systems from weight, cost and development risk standpoints. Author

**N79-21335\*** Lockheed Missiles and Space Co., Palo Alto, Calif. Research Lab.

**LASER POWER CONVERSION SYSTEM ANALYSIS, VOLUME 2 Final Report, 26 Sep. 1977 - 26 Sep. 1978**

W. S. Jones, L. L. Morgan, J. B. Forsyth, and J. P. Skratt  
15 Mar. 1979 112 p refs

(Contract NAS3-21137)

(NASA-CR-159523-Vol-2; LMSC-D673466-Vol-2) Avail: NTIS HC A06/MF A01 CSCL 20E

The orbit-to-ground laser power conversion system analysis investigated the feasibility and cost effectiveness of converting solar energy into laser energy in space, and transmitting the laser energy to earth for conversion to electrical energy. The analysis included space laser systems with electrical outputs on the ground ranging from 100 to 10,000 MW. The space laser power system was shown to be feasible and a viable alternate to the microwave solar power satellite. The narrow laser beam provides many options and alternatives not attainable with a microwave beam. Author

**N79-21390\*** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.  
**A LOW COST HIGH TEMPERATURE SUN TRACKING SOLAR ENERGY COLLECTOR**

Gerald S. Perkins /In NASA. Goddard Space Flight Center  
The 11th Aerospace Mech. Symp. 28 Apr. 1977 p 163-175

(Contract NAS7-100)

Avail: NTIS HC A11/MF A01 CSCL 20K

The design and economic evaluation of a low cost high temperature two-axis, sun tracking solar energy collector is described. The collector design was specifically intended for solar energy use with the freedom of motion about its two control axes limited only to the amplitude required to track the sun. An examination of the performance criteria required in order to track the sun and perform the desired solar energy conversion was used as the starting point and guide to the design. This factor, along with its general configuration and structural aspect ratios, was the significant contributor to achieving low cost. The unique mechanical design allowed the control system to counter wide tolerances specified for the fabrication of the azimuth frame and to perform within a small tracking error. J.A.M.

**N79-21392\*** Aerospatiale Etablissement des Mureaux (France).  
**DEVELOPMENT OF A SATELLITE FLYWHEEL FAMILY OPERATING ON ONE ACTIVE AXIS MAGNETIC BEARINGS**

Pierre C. Poubeau /In NASA. Goddard Space Flight Center  
The 11th Aerospace Mech. Symp. 28 Apr. 1977 p 185-201

Avail: NTIS HC A11/MF A01 CSCL 20K

Since the samarium-cobalt magnets were available at industrial level, new possibilities appeared in the area of magnetic bearings with the radial passive centering and axial control of the rotor position. Magnetic bearings of this type on which a wide effort was made towards the optimization for satellite flywheel applications are described. Also, the momentum and reaction wheels were considered. This work was extended to the kinetic storage of energy for satellites. J.A.M.

**N79-21406\*** Southwest Research Inst., San Antonio, Tex. Dept. of Engine and Vehicle Research.

**SINGLE-CYLINDER DIESEL ENGINE TESTS WITH UNSTABILIZED WATER-IN-FUEL EMULSIONS Final Report, Jan. 1977 - Jun. 1977**

J. O. Stormont and C. W. Coon Aug. 1978 89 p refs

(Contract DOT-TSC-920)

(AD-A062751; USCG-D-13-78; TSC-USCG-77-4) Avail: NTIS HC A05/MF A01 CSCL 21/4

A single-cylinder, four-stroke cycle diesel engine was operated on unstabilized water-in-fuel emulsions. Two prototype devices were used to produce the emulsions on-line with the engine. More than 350 test points were run with baseline diesel fuel and emulsified water-in-fuel. Water content of the emulsified fuel varied from about 2% to 23% by volume. Statistically significant decreases in fuel consumption, ranging from 1.2% to 5.1% were obtained with emulsified fuels in 20 out of 36 test conditions. An increase of 2.5% was measured at one condition only. Use of the emulsified fuels decreased oxides of nitrogen by up to about 60% and Bosch smoke numbers by up to almost 70%, whereas unburned hydrocarbons increased up to over 130%. Carbon monoxide changes with emulsified fuel varied from a decrease of 52% to an increase of over 170%, depending on engine speed and power, and water content of the fuel. No problems were encountered in engine operation at any test condition with the water-in-fuel emulsions. Author (GRA)

**N79-21429\*** Rocketdyne, Canoga Park, Calif.

**HYDROGEN EMBRITTLEMENT AND ITS CONTROL IN HYDROGEN-FUELED ENGINE SYSTEMS**

W. T. Chandler /In NASA. Langley Res. Center Recent Advan. in Structures for Hypersonic Flight, Pt. 1, 1978 p 195-249 refs

(Contract NAS8-27980)

Avail: NTIS HC A23/MF A01 CSCL 20K

The nature of hydrogen embrittlement by high pressure gaseous hydrogen is described and methods of designing SSME gaseous hydrogen systems, including techniques of hydrogen embrittlement prevention, are discussed. The effects of gaseous hydrogen environments are emphasized. Results of extensive investigations of gaseous hydrogen environments on metals conducted under the SSME program are presented. J.M.S.

**N79-21523\*** GeoEnergy Corp., Las Vegas, Nev.

**AN ASSESSMENT OF SUBSURFACE SALT WATER DISPOSAL EXPERIENCE ON THE TEXAS AND LOUISIANA GULF COAST FOR APPLICATION TO DISPOSAL OF SALT WATER FROM GEOPRESSURED GEOTHERMAL WELLS**

C. F. Knutson and C. R. Boardman 4 Aug. 1978 78 p refs  
(Contract EY-77-C-08-1531)

(NVO/1531-2) Avail: NTIS HC A05/MF A01

The primary problems with respect to salt water disposal in the Gulf Coast area in general were determined from literature and current experience. High rate salt water disposal well data obtained for 8 specific counties in Texas and 10 parishes in Louisiana. Salt water disposal data and operating experience information were obtained from major gas and oil companies operating in the areas of interest, from DOE's strategic petroleum reserve program, and from an industrial waste engineering firm based in Houston. A prognosis is provided for the subsurface disposal of salt water at rates equal to or greater than approximately 3,000 bbls/day or 1,000,000 bbls/yr per well. Gulf Coast geology is reviewed and the mechanical, chemical, environmental, and legal aspects of salt water disposal are examined. A.R.H.

**N79-21530#** Massachusetts Inst. of Tech., Cambridge. Dept. of Earth and Planetary Sciences.

**MICROCRACK TECHNOLOGY FOR GEOTHERMAL EXPLO-  
RATION AND ASSESSMENT Final Report, 1 Mar. 1978 -  
31 Aug. 1978**

Gené Simmons 31 Aug. 1978 297 p refs  
(Grants NSF AER-75-09588; NSF DAR-75-09588-A01)  
(PB-290173/4; NSF/RA-780302) Avail: NTIS  
HC A13/MF A01 CSCL 081

Repeated fracturing and fracture sealing were observed in core samples from six geothermal areas. Both fracture porosity and morphology vary widely. The minerals that seal fractures show significant temporal variations. Water-rock reactions and alteration often produce low density or hydrous phases that further seal and block cracks. Such parameters as hydraulic permeability and electrical conductivity that influence the geologic environment or serve as geothermal indicators, are dependent on the fracture state of the rock. The microfractures from these geothermal areas have several distinctive characteristics which are explained. The microfractures in geothermal rocks reflect the dynamics of the geothermal system. The results of this investigation are applicable to several problems encountered in the exploration for geothermal areas and evaluation of the reservoir: (1) locating the geothermal areas; (2) interpretation of electrical surveys; and (3) prediction of reservoir characteristics and reservoir behavior during exploration. GRA

**N79-21638#** National Aeronautics and Space Administration, Washington, D. C.

**SATELLITE POWER SYSTEM: CONCEPT DEVELOPMENT  
AND EVALUATION PROGRAM, REFERENCE SYSTEM  
REPORT**

Jan. 1979 321 p refs Prepared in cooperation with DOE, Washington, D. C.  
(NASA-TM-79762; DOE/ER-0023) Avail: NTIS  
HC A14/MF A01 CSCL 10B

The Satellite Power System (SPS) Reference System is discussed and the technical and operational information required in support of environmental, socioeconomic, and comparative assessment studies are emphasized. The reference System concept features a gallium-aluminum-arsenide, and silicon solar cell options. Other aspects of an SPS are the construction of bases in space, launch and mission control bases on earth, and fleets of various transportation vehicles to support the construction and maintenance operations of the satellites. M.M.M.

**N79-21641** South Carolina Univ., Columbia.

**A STUDY OF THE EFFECTIVE RESISTANCE OF THE  
DIFFUSED LAYER AND ITS EFFECT ON SOLAR CELL  
PERFORMANCE Ph.D. Thesis**

Yingsheng Tung 1978 123 p  
Avail: Univ. Microfilms Order No. 7907638

The series resistance associated with the solar cell was proven to be a limiting factor on the conversion efficiency. The contribution from the diffused layer to the total series resistance is analyzed using a numerical method. It is found that the relationship between the current and the voltage in the diffused layer is nonlinear; consequently, the electrical behavior of this layer can not be described by a resistance of constant value. Another approach for synthesizing the solar cell design is proposed using unit fields as building blocks. Since the total power output from a cell can be derived from that of the constituent unit fields, the performance of the cell as a whole can be predicted once the current and voltage characteristics of the unit field are known. A procedure is described which enables one to accomplish this through the construction of the I-V curves of each unit field. Dissert. Abstr.

**N79-21643#** Agricultural and Technical Coll. of North Carolina, Greensboro. Department of Electrical Engineering.

**MATERIAL GROWTH AND CHARACTERIZATION DI-  
RECTED TOWARD IMPROVING III-V HETEROJUNCTION  
SOLAR CELLS Annual Report, 1 Feb. 1978 - 31 Jan. 1979**

Elias K. Stefanakos, Winsor E. Alexander, Ward Collis, and Ali Abul-Fadi 31 Jan. 1979 88 p refs  
(Grant NSG-1390)

(NASA-CR-158476) Avail: NTIS HC A05/MF A01 CSCL 10A

In addition to the existing materials growth laboratory, the photolithographic facility and the device testing facility were completed. The majority of equipment for data acquisition, solar cell testing, materials growth and device characterization were received and are being put into operation. In the research part of the program, GaAs and GaAlAs layers were grown reproducibly on GaAs substrates. These grown layers were characterized as to surface morphology, thickness and thickness uniformity. The liquid phase epitaxial growth process was used to fabricate p-n junctions in Ga(1-x)Al(x)As. Sequential deposition of two alloy layers was accomplished and detailed analysis of the effect of substrate quality and dopant on the GaAlAs layer quality is presented. Finally, solar cell structures were formed by growing a thin p-GaAlAs layer upon an epitaxial n-GaAlAs layer. The energy gap corresponding to the long wavelength cutoff of the spectral response characteristic was 1.51-1.63 eV. Theoretical calculations of the spectral response were matched to the measured response. L.S.

**N79-21645#** Boeing Engineering and Construction, Seattle, Wash.

**FEASIBILITY STUDY OF SOLAR DOME ENCAPSULATION  
OF PHOTOVOLTAIC ARRAYS Final Report**

Dec. 1978 175 p refs Sponsored by NASA Prepared for DOE and JPL

(Contract JPL-954833)  
(NASA-CR-158368; DOE/JPL-954833-78/1) Avail: NTIS  
HC A08/MF A01 CSCL 10A

The technical and economic advantages of using air-supported plastic enclosures to protect flat plate photovoltaic arrays are described. Conceptual designs for a fixed, latitude-tilt array and a fully tracking array were defined. Detailed wind loads and strength analyses were performed for the fixed array. Detailed thermal and power output analyses provided array performance for typical seasonal and extreme temperature conditions. Costs of each design as used in a 200 MWe central power station were defined from manufacturing and material cost estimates. The capital cost and cost of energy for the enclosed fixed-tilt array were lower than for the enclosed tracking array. The enclosed fixed-tilt array capital investment was 38% less, and the leveled bus bar energy cost was 26% less than costs for a conventional, glass-encapsulated array design. The predicted energy cost for the enclosed fixed array was 79 mills/kW-h for direct current delivered to the power conditioning units. L.P.

**N79-21647#** Rasor Associates, Inc., Sunnyvale, Calif.  
**POWER COUPLING ALTERNATIVES FOR THE NEP  
THERMIONIC POWER SYSTEM Final Report**

M. L. Manda, E. J. Britt, and G. O. Fitzpatrick Dec. 1978 64 p refs Prepared for JPL

(Contracts NAS7-100; JPL-955121)  
(NASA-CR-158372; NSR-7-1) Avail: NTIS HC A04/MF A01

Three output power coupling methods which can eliminate the high temperature insulator from the Nuclear Electric Propulsion (NEP) power system are described and estimates of their effects on the NEP system masses and cooling requirements are presented. Nominal 400 kWe power systems using push-pull and flux reset inductive output coupling are shown to have specific masses of 22.2 kg/kWe and 18.8 kg/kWe, respectively. Series connected heat pipe systems, which use the heat pipe-to-heat pipe resistance to isolate converters on adjacent heat pipes, are shown to have specific masses 0.5 to 1.4 kg/kWe lower than the NEP baseline system. Increasing the number and temperature of the heat pipes in the system without changing the electric output reduces the calculated system specific mass only slightly, whereas increasing the output power significantly reduces the specific mass. Estimates of cooling requirements indicate that 11-45 sq m of power conditioning radiator are needed. A possible location for the power conditioning radiator may be in the present location of the kapton sputter shield. M.M.M.



**N79-21548\*** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.  
**THERMAL POWER SYSTEMS SMALL POWER SYSTEMS APPLICATIONS PROJECT. DECISION ANALYSIS FOR EVALUATING AND RANKING SMALL SOLAR THERMAL POWER SYSTEM TECHNOLOGIES. VOLUME 1: A BRIEF INTRODUCTION TO MULTIATTRIBUTE DECISION ANALYSIS**

A. Feinberg and R. F. Miles, Jr. 1 Jun. 1978 30 p refs  
Prepared for DOE  
(Contract NAS7-100)  
(NASA-CR-158425; DOE/JPL-1060-15; JPL-Pub-79-12-Vol-1; Rept-5103-47-Vol-1) Avail: NTIS HC A03/MF A01 CSCL 10A

The principal concepts of the Keeney and Raiffa approach to multiattribute decision analysis are described. Topics discussed include the concepts of decision alternatives, outcomes, objectives, attributes and their states, attribute utility functions, and the necessary independence properties for the attribute states to be aggregated into a numerical representation of the preferences of the decision maker for the outcomes and decision alternatives. L.P.

**N79-21549\*** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.  
**EVALUATION OF MOSTAS COMPUTER CODE FOR PREDICTING DYNAMIC LOADS IN TWO BLADED WIND TURBINES**

K. R. V. Kaza (Toledo Univ.), D. C. Janetzke, and T. L. Sullivan 1979 21 p refs Presented at AIAA/ASCE/AHS 20th Structures, Structural Dynamics and Mater. Conf., St. Louis, Mo., 4-6 Apr. 1979

(Contract E(49-26)-1028)  
(NASA-TM-79101; DOE/NASA/1028-72/2; E-9925) Avail: NTIS HC A02/MF A01 CSCL 10B

Calculated dynamic blade loads were compared with measured loads over a range of yaw stiffnesses of the DOE/NASA Mod-O wind turbine to evaluate the performance of two versions of the MOSTAS computer code. The first version uses a time-averaged coefficient approximation in conjunction with a multi-blade coordinate transformation for two bladed rotors to solve the equations of motion by standard eigenanalysis. The second version accounts for periodic coefficients while solving the equations by a time history integration. A hypothetical three-degree of freedom dynamic model was investigated. The exact equations of motion of this model were solved using the Floquet-Lipunov method. The equations with time-averaged coefficients were solved by standard eigenanalysis. L.P.

**N79-21550\*** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.  
**THE ROLE OF THERMAL ENERGY STORAGE IN INDUSTRIAL ENERGY CONSERVATION**

Rudolph A. Duscha and William J. Masica 1979 13 p refs Presented at a Conf. on Ind. Energy Conserv. Technol. and Exhibition, Houston, Tex., 22-25 Apr. 1979; sponsored by DOE and the Texas Ind. Comm.

(Contract EC-77-A-31-1034)  
(NASA-TM-79122; DOE/NASA/1034-79/1; E-9957) Avail: NTIS HC A02/MF A01 CSCL 10C

Thermal Energy Storage for Industrial Applications is a major thrust of the Department of Energy's Thermal Energy Storage Program. Utilizing Thermal Energy Storage (TES) with process or reject heat recovery systems is shown to be extremely beneficial for several applications. Recent system studies resulting from contracts awarded by the Department of Energy (DOE) identified four especially significant industries where TES appears attractive - food processing, paper and pulp, iron and steel, and cement. Potential annual fuel savings with large scale implementation of near term TES systems for these industries is over 9,000,000 bbl of oil. This savings is due to recuperation and storage in the food processing industry, direct fuel substitution in the paper and pulp industry and reduction in electric utility peak fuel use through inplant production of electricity from utilization of reject heat in the steel and cement industries. Author

**N79-21551\*** ECON, Inc., Princeton, N. J.  
**ASSESSMENT OF ECONOMIC FACTORS AFFECTING THE SATELLITE POWER SYSTEM. VOLUME 1: SYSTEM COST FACTORS Final Report**

George A. Hazelrigg, Jr. 15 Dec. 1978 175 p refs  
(Contract NAS8-33002)  
(NASA-CR-161185; Econ-78-147-1) Avail: NTIS HC A08/MF A01 CSCL 10B

The factors relevant to SPS costing and selection of preferred SPS satellite configurations were studied. The issues discussed are: (1) consideration of economic factors in the SPS system that relate to selection of SPS satellite configuration; (2) analysis of the proper rate of interest for use in SPS system definition studies; and (3) the impacts of differential inflation on SPS system definition costing procedures. A cost-risk comparison of the SPS satellite configurations showed a significant difference in the leveled cost of power from them. It is concluded, that this difference is the result more of differences in the procedures for assessing costs rather than in the satellite technologies required or of any advantages of one satellite configuration over the other. Analysis of the proper rate of interest for use in SPS system is 4 percent. The major item of differential inflation to be expected over this period of time is the real cost of labor. This cost is likely to double between today and the period of SPS construction. M.M.M.

**N79-21552\*** Little (Arthur D.), Inc., Cambridge, Mass.  
**ASSESSMENT OF ECONOMIC FACTORS AFFECTING THE SATELLITE POWER SYSTEM. VOLUME 2: THE SYSTEMS IMPLICATIONS OF RECTENNA SITING ISSUES Final Report**

Philip K. Chapman, Beverly J. Bugos, Katinka I. Csigi, Peter E. Glaser, Gerald R. Schimke, and Richard G. Thomas 8 Mar. 1979 66 p refs Prepared for ECON, Inc., Princeton, N. J.  
(Contract NAS8-33002)  
(NASA-CR-161186) Avail: NTIS HC A04/MF A01 CSCL 10B

The feasibility was evaluated of finding potential sites for Solar Power Satellite (SPS) receiving antennas (rectennas) in the continental United States, in sufficient numbers to permit the SPS to make a major contribution to U.S. generating facilities, and to give statistical validity to an assessment of the characteristics of such sites and their implications for the design of the SPS system. It is found that the cost-optimum power output of the SPS does not depend on the particular value assigned to the cost per unit area of a rectenna and its site, as long as it is independent of rectenna area. Many characteristics of the sites chosen affect the optimum design of the rectenna itself. Author

**N79-21554\*** Honeywell, Inc., Minneapolis, Minn.  
**ACTIVE HEAT EXCHANGE SYSTEM DEVELOPMENT FOR LATENT HEAT THERMAL ENERGY STORAGE**

R. T. LeFrois, G. R. Knowles, A. K. Mathur, and J. Budimir Feb. 1979 122 p refs  
(Contracts DEN-3-38; EC-77-A-31-1034)  
(NASA-CR-159479; HI-78336; DOE/NASA/0038-79/1) Avail: NTIS HC A06/MF A01 CSCL 10A

Active heat exchange concepts for use with thermal energy storage systems in the temperature range of 250 C to 350 C, using the heat of fusion of molten salts for storing thermal energy are described. Salt mixtures that freeze and melt in appropriate ranges are identified and are evaluated for physicochemical, economic, corrosive and safety characteristics. Eight active heat exchange concepts for heat transfer during solidification are conceived and conceptually designed for use with selected storage media. The concepts are analyzed for their scalability, maintenance, safety, technological development and costs. A model for estimating and scaling storage system costs is developed and is used for economic evaluation of salt mixtures and heat exchange concepts for a large scale application. The importance of comparing salts and heat exchange concepts on a total system cost basis, rather than the component cost basis alone, is pointed out. The heat exchange concepts were sized and compared for 6.5 MPa/281 C steam conditions and a 1000 MW(t) heat rate for six hours. A cost sensitivity analysis for other design conditions is also carried out. L.P.



**N79-21555#** California Univ., Berkeley. Lawrence Berkeley Lab.

**A COMPUTERIZED REPORTING AND MONITORING SYSTEM FOR GEOTHERMAL ENERGY DEVELOPMENT**

S. L. Phillips, M. Tavana, K. Leung, M. Steyer, W. A. Palen, and S. R. Schwartz Dec. 1978 62 p refs

(Contract W-7405-eng-48)

(LBL-8483) Avail: NTIS HC A04/MF A01

It is proposed that the on-going compilation and critical evaluation of data be expanded to include a computerized system for monitoring and reporting the development of geothermal resources from the discovery phase to power on-line. Data would be covered which is site-specific and therefore unique to the geothermal area. Computer printouts are to contain a listing of each geothermal site which will be classified according to the status of development for producing electrical power. The result of the work will consist of a report containing a description of the data at each site and recommendations for additional data needs in technological, economic, or institutional areas. The computerized system will allow for ease in updating and remote accessing by off-site users. Author

**N79-21556#** Westinghouse Research and Development Center, Pittsburgh, Pa.

**THIN FILM BATTERY/FUEL CELL POWER GENERATING SYSTEM Final Report, Apr. 1976 - Apr. 1978**

31 Mar. 1978 226 p refs

(Contract EY-76-C-03-1197)

(CONS/1197-9) Avail: NTIS HC A11/MF A01

A rare-earth chromite was identified and synthesized by RF-sputtering. It was tested for resistivity, thermal expansion and inertness in contact with yttria-stabilized zirconia, and was used as an interconnection material. Films of these interconnection materials were successfully deposited onto stabilized zirconia tubes by electrochemical vapor deposition. This technique was used to fabricate such films in building fuel cell stacks. Tin-doped indium oxide and antimony-doped tin oxide air electrode current collector materials were successfully chemically vapor deposited, as thin films, onto zirconia tubes. An in-house extrusion technology for porous calcia-stabilized zirconia tubes were developed and used to provide suitable support tubes for component combination samples, unit cell and cell stack sample preparation. L.P.

**N79-21557#** Battelle Pacific Northwest Labs., Richland, Wash. **DEVELOPMENT, CHARACTERIZATION AND EVALUATION OF MATERIALS FOR OPEN CYCLE MHD**

J. Lambert Bates, D. D. Marchant, and J. L. Daniel Aug. 1978 44 p refs

(Contract EY-76-C-06-1830)

(PNL-2004-8) Avail: NTIS HC A03/MF A01

Progress in the development of high temperature ceramics for open cycle, coal-fired MHD power generators is reported. Emphasis is placed on electrode and insulator materials. Specific areas covered include: (1) electrochemical effects of alkali seed/coal slags on electrodes and insulators; (2) characterization of material from Westinghouse MHD proof tests; (3) thermal diffusivity/conductivity; (4) electrical conductivity of oxide insulators; and (5) materials development. J.M.S.

**N79-21558#** Westinghouse Electric Corp., Pittsburgh, Pa. Advanced Energy Systems Div.

**DEVELOPMENT, TESTING AND EVALUATION OF MHD MATERIALS AND COMPONENT DESIGNS Quarterly Report, Jan. - Mar. 1978**

John W. Sadler, Jeff Bein, David L. Black, Raymond Calvo, Laurence H. Cadoff (Westinghouse Res. and Develop. Center), James A. Dilmore (Westinghouse Res. and Develop. Center), Gary E. Driesen, Alfred G. Eggers, Edsel W. Frantti, and Edgar L. Kochka May 1978 160 p refs

(Contract EX-76-C-01-2248)

(FE-2248-19) Avail: NTIS HC A08/MF A01

Electrodes were evaluated for both clean and coal fired environments. Electrochemical screening tests in simulated liquid slags, conducted to provide additional information on the chemistry, mechanisms, and kinetics of electrode/slag reactions

are described. The U-02 post-test materials characterization provided the basis for the selection of LaCrO<sub>3</sub> - based electrode materials with compliant Ni-mesh attachments for the U-02 phase 3 electrode walls. Materials developed and detail design activities in support of the U-02 phase 3 module were continued, and U-02 phase 3 electrode sub-assemblies were prepared. A.R.H.

**N79-21559#** Allied Chemical Corp., Idaho Falls, Idaho. Chemical Programs - Operations Office.

**LIQUID-FLUIDIZED-BED HEAT EXCHANGER FLOW DISTRIBUTION MODELS**

L. T. Cole and C. A. Allen Jan. 1979 20 p refs

(Contract EY-76-C-07-1540)

(ICP-1151) Avail: NTIS HC A02/MF A01

Liquid-fluidized-bed shell-and-tube heat exchangers for geothermal applications are considered. Sand fluidized by geothermal water on the shell side prevents scaling and increases heat transfer coefficients over conventional heat exchangers. Tests conducted on two instrumented fluidized-bed heat exchanger models, constructed primarily of plexiglass, which differ in tube bundle orientation are described. Plexiglass construction allowed visual observation of flow patterns. The vertical model proved to have more uniform flow distribution and higher heat transfer coefficients than the horizontal model. The horizontal heat exchanger experienced piling on top of the tubes and areas of poor fluidization existed in the bed. Geometric considerations show that a horizontal design is more conducive to large flow rates than a vertical design. New design concepts for both vertical and horizontal assemblies and recommendations for further developmental work are presented. J.M.S.

**N79-21560#** Avco-Everett Research Lab., Mass.

**ENGINEERING TEST FACILITY CONCEPTUAL DESIGN, PART 1 Final Report**

Jun. 1978 561 p

(Contract EF-77-C-01-2614)

(FE-2614-2-Pt-1) Avail: NTIS HC A24/MF A01

The final document reporting material and information developed in the ETF (Engineering Test Facility) Conceptual Design Activity of the Department of Energy is presented. The specific ETF reference system design recommended in the previous preliminary ETF conceptual Design Document of December 1977 is reported. The major design goals of the ETF are: (1) to provide for demonstration of long duration of a complete combined MHD (magnetohydrodynamic)/steam power system of pilot scale with coal as the primary fuel source; (2) to provide for testing and evaluation of the overall system, subsystem and components performance, controls and interactions, and to identify and resolve critical problem areas; and (3) to provide design information and the necessary engineering base and confidence for subsequent commercialization of open cycle MHD power generation. G.Y.

**N79-21561#** Avco-Everett Research Lab., Mass.

**ENGINEERING TEST FACILITY CONCEPTUAL DESIGN, PART 2 Final Report**

Jun. 1978 486 p refs

(Contract EF-77-C-01-2614)

(FE-2614-2-Pt-2) Avail: NTIS HC A21/MF A01

Part 2 of a two part final document is presented and reports on materials and information developed in the ETF (Engineering Test Facility) Design Activity of the Department of Energy. The ETF goals are to design, operate and evaluate a complete combined MHD (magnetohydrodynamic)/steam power system of pilot plant scale with coal as the primary fuel source. Part 2 discusses the steam plant, instrumentation and control, plant layout, maintenance and service, buildings and structures, and site and site development. G.Y.

**N79-21562#** Oak Ridge National Lab., Tenn.

**TRANSPORTATION ENERGY CONSERVATION DATA BOOK, EDITION 3**

D. B. Shonka, ed. Feb. 1979 555 p refs

(Contract W-7405-eng-26)

(ORNL-5493) Avail: NTIS HC A24/MF A01

All major modes of transportation are represented: highway, air, rail, marine, and pipeline. Various aspects of the transportation sector discussed: (1) modal characteristics, (2) current energy use, efficiency and conservation, (3) projections of modal energy use, (4) impact of government activities, (5) supply and cost of energy, and (6) general demographic and economic characteristics. More than 400 tables and figures show the following transportation stock and use statistics: number of vehicles, vehicle miles traveled, passenger-miles and freight ton-miles, fleet characteristics, household automobile ownership, size of mix of automobiles, vehicle travel characteristics, and commuting patterns. Energy characteristics presented include energy use by fuel source and transportation mode, energy intensity figures by mode, indirect energy use, production as a percent of consumption, imports as a percent of domestic production, energy prices from the wellhead to the retail outlet, and alternative fuels. A.R.H.

**N79-21563#** AiResearch Mfg. Co., Torrance, Calif.  
**WAYSIDE ENERGY STORAGE SUMMARY. VOLUME 1: SUMMARY Final Report, May 1977 - Jun. 1978**  
L. J. Lawson and L. M. Cook Feb. 1979 76 p refs 2 Vol.  
(Contract DOT-TSC-1349-1)  
(DOT-TSC-FRA-79-7-1-Vol-1; FRA/ORD-78-1-Vol-1) Avail:  
NTIS HC A05/MF A01

An in-depth application study was conducted to determine the practicality and viability of using large wayside flywheels to recuperate braking energy from freight trains on long downgrades. The study examined the route structures of nine U.S. railroads and identified various wayside energy storage system (WESS) configurations. The optimum means voltage ac catenary from either regenerative electric locomotives or modified dual-mode (diesel-electric/electric) locomotives. The application of WESS was analyzed for four specific routes of typical U.S. railroads. These routes and the annual returns on investment resulting from WESS deployment on existing railroads were as follows: Atchinson, Topeka, and Santa Fe (Los Angeles to Belen), 27.1 percent; Black Mesa and Lake Powell, 17.3 percent; Conrail (Pittsburgh to Harrisburg), 22.0 percent; Union Pacific (Los Angeles to Salt Lake City) 20.2 percent. L.S.

**N79-21564#** Brookhaven National Lab., Upton, N. Y. Economic Analysis Div.  
**THE BROOKHAVEN BUILDINGS ENERGY CONSERVATION OPTIMIZATION MODEL**  
Steven C. Carhart, Shirish S. Mulherkar, and Yasuko Sanborn Jan. 1978 85 p refs  
(Contract EY-76-C-02-0016)  
(BNL-50828) Avail: NTIS HC A05/MF A01

The Brookhaven Buildings Energy Conservation Optimization Model is a linear programming representation of energy use in buildings. Starting with engineering and economic data on cost and performance of energy technologies used in buildings, including both conversion devices (such as heat pumps) and structural improvements, the model constructs alternative flows for energy through the technologies to meet demands for space heating, air conditioning, thermal applications, and electric lighting and appliances. Alternative paths have different costs and efficiencies. Within constraints such as total demand for energy services, retirement of existing buildings, seasonal operation of certain devices, and others, the model calculates an optimal configuration of energy technologies in buildings. Author

**N79-21565#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.  
**THE 1977 GODDARD SPACE FLIGHT CENTER BATTERY WORKSHOP**  
1977 579 p Workshop held at Greenbelt, Md., 15-17 Nov. 1977  
(NASA-CP-2041) Avail: NTIS HC A25/MF A01 CSCL 10C

The papers presented were derived from transcripts taken at the Tenth Annual Battery Workshop held at the Goddard Space Flight Center, November 15-17, 1977. The Workshop was attended by manufacturers, users, and government representatives interested in the latest results of testing, analysis, and development of the sealed nickel cadmium cell system. The

purpose of the Workshop was to share flight and test experience, stimulate discussion on problem areas, and to review the latest technology improvements.

**N79-21571#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.  
**SYNCHRONOUS METEOROLOGICAL AND GEOSTATIONARY OPERATIONAL ENVIRONMENTAL SATELLITES BATTERY AND POWER SYSTEM DESIGN**  
Dave A. Baer and Walter J. Schedler (Natl. Environ. Satellite Serv., Suitland, Md.) In *its* The 1977 Goddard Space Flight Center Battery Workshop 1977 p 69-79

Avail: NTIS HC A25/MF A01 CSCL 10C

The battery was a three ampere hour nickel cadmium prismatic cell. The battery consists of 20 cells connected in series and there were two batteries per spacecraft. The battery operations (voltage and temperature) that the spacecraft sees during a normal operational day are discussed. G.Y.

**N79-21574#** National Aeronautics and Space Administration, Washington, D. C.  
**NASA'S OAST PROGRAM: AN OVERVIEW**  
Lee Holcomb In *NASA. Goddard Space Flight Center The 1977 Goddard Space Flight Center Battery Workshop 1977* p 111-118  
Avail: NTIS HC A25/MF A01 CSCL 10C

The program was split into four areas which include: high energy density, long life batteries; low cost high capacity battery application; very high energy density batteries; and electrochemical research and technology program. Outlines are presented which show the approaches used and the accomplishments of each program area. G.Y.

**N79-21575#** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.  
**EFFECT OF THE JET PROPULSION LABORATORY**  
Sam Bogner In *NASA. Goddard Space Flight Center The 1977 Goddard Space Flight Center Battery Workshop 1977* p 119-132 Sponsored by NASA

Avail: NTIS HC A25/MF A01 CSCL 10C

A discussion is presented which gives an overview of the research and technological areas on nickel cadmium batteries at the Jet Propulsion Laboratory. Some of the topics covered include: goals; failure modes and mechanisms; factors of degradation and some possible solutions; energy density; and accomplishments for FY 77 and FY 78. G.Y.

**N79-21576#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.  
**LEWIS RESEARCH CENTER PROGRAM**  
D. G. Soltis In *NASA. Goddard Space Flight Center The 1977 Goddard Space Flight Center Battery Workshop 1977* p 133-136  
Avail: NTIS HC A25/MF A01 CSCL 10C

As part of the NASA lightweight battery program, the Lewis Research Center has a number of programs that are being reviewed. A brief and general discussion of these programs is presented. G.Y.

**N79-21577#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.  
**ACCELERATED TEST PROGRAM**  
Floyd E. Ford and J. M. Harkness (Naval Weapons Support Center) In *its* The 1977 Goddard Space Flight Center Battery Workshop 1977 p 137-140  
Avail: NTIS HC A25/MF A01 CSCL 10C

A brief discussion on the accelerated testing of batteries is given. The statistical analysis and the various aspects of the modeling that was done and the results attained from the model are also briefly discussed. G.Y.

**N79-21603\*** McDonnell-Douglas Astronautics Co., Huntington Beach, Calif.

# **THE 100 kW SPACE STATION**

George McKhann *In* NASA. Goddard Space Flight Center The 1977 Goddard Space Flight Center Battery Workshop 1977 p 451-461

Avail: NTIS HC A25/MF A01 CSCL 10C

Solar array power systems for the space construction base are discussed. Nickel cadmium and nickel hydrogen batteries are equally attractive relative to regenerative fuel cell systems at 5 years life. Further evaluation of energy storage system life (low orbit conditions) is required. Shuttle and solid polymer electrolyte fuel cell technology appears adequate; large units (approximately four times shuttle) are most appropriate and should be studied for a 100 KWe SCB system. A conservative NiH2 battery DOD (18.6%) was elected due to lack of test data and offers considerable improvement potential. Multiorbit load averaging and reserve capacity requirements limit nominal DOD to 30% to 50% maximum, independent of life considerations.

Author

**N79-21604\*** Grumman Aerospace Corp., Bethpage, N.Y.

# **THE 25 kW SPACE STATION**

Bruce Clark *In* NASA. Goddard Space Flight Center The 1977 Goddard Space Flight Center Battery Workshop 1977 p 463-474

Avail: NTIS HC A25/MF A01 CSCL 10C

The capabilities of photovoltaic, nuclear reactor, and solar thermal systems are assessed for the space construction base. Topics covered include Brayton conversion, thermionic conversion, and thermo-electric conversion. The effectiveness of nickel cadmium and nickel hydrogen batteries are discussed as well as that of regenerative fuel cells. The verification of long cycle life for nickel hydrogen systems is recommended. A.R.H.

**N79-21610\*** Eagle-Picher Industries, Inc., Joplin, Mo.

# **MULTISTACK NICKEL-HYDROGEN UNITS**

Jim Smith *In* NASA. Goddard Space Flight Center The 1977 Goddard Space Flight Center Battery Workshop 1977 p 519-524

Avail: NTIS HC A25/MF A01 CSCL 10C

A typical 625 Inconel pressure vessel, equipped with four thermocouples, has voltage taps not only for the cell, but for each of the several packs inside the container. In a two-stack design, a weld ring is used to separate the packs which, joined together, form one solid group. In the four-stack design, stacks are separated mechanically with about half inch Plexiglas and are connected through the center. Electrolytes are forced out by vacuum. The two stack design is intended for 500 psi and was pressure tested up to 1,000. The problem of electrolyte shorts is discussed and possible solutions for its correction are given. A.R.H.

**N79-21618\*** National Aeronautics and Space Administration, Marshall Space Flight Center, Huntsville, Ala.

# **DEVELOPMENT, TESTING, AND CERTIFICATION OF THE NORTHRUP, INC., ML SERIES CONCENTRATING SOLAR COLLECTOR MODEL NSC-01-0732 Final Report**

John C. Parker Mar. 1979 27 p refs

(NASA-TM-78219) Avail: NTIS HC A03/MF A01 CSCL 10A

A summary is presented of the additional development work on the existing ML Series concentrating solar collector for use with solar heating and cooling systems. The report discusses the intended use of the final report, describes the development hardware, lists deliverable end items, deals with problems encountered during fabrication and testing, and includes certification statements of performance. This report shows that the products developed are marketable and suitable for public use. L.S.

**N79-21619\*** Sunkeeper Control Corp., Andover, Mass.

# **DESIGN PACKAGE FOR PROGRAMMABLE CONTROLLER AND HYDRONIC SUBSYSTEM**

Mar. 1979 28 p Prepared for DOE

(Contract NAS8-32257)

(NASA-CR-161151) Avail: NTIS HC A03/MF A01 CSCL 10A

Information used in the evaluation of design of Sunkeeper Control's electronic controllers and hydronic packages is discussed. This information includes system performance specifications, a design data brochure, drawings, and qualification and acceptance test procedures. L.P.

**N79-21620\*** National Aeronautics and Space Administration, Marshall Space Flight Center, Huntsville, Ala.

# **DEVELOPMENT, TESTING, AND CERTIFICATION OF OWENS-ILLINOIS MODEL SEC-601 SOLAR ENERGY COLLECTOR SYSTEM Final Report**

John C. Parker Mar. 1979 22 p refs Prepared for DOE

(NASA-TM-78223) Avail: NTIS HC A02/MF A01 CSCL 10A

The final results are presented of the additional development work on the existing air-cooled solar energy collector subsystem for use with solar heating and cooling systems. The report discusses the intended use of the final report, describes the deliverable end items, lists program objectives, relates how they were accomplished, deals with problems encountered during fabrication and testing, and includes a certification statement of performance. The report shows that the products developed are marketable and suitable for public use. L.S.

**N79-21621\*** Wyle Labs., Inc., Huntsville, Ala. Solar Energy Systems Div.

# **LONG TERM WEATHERING EFFECTS ON THE THERMAL PERFORMANCE OF THE SOLARON (AIR) SOLAR COLLECTOR**

Mar. 1979 12 p refs Prepared for DOE

(Contract NAS8-32036)

(NASA-CR-161166) Avail: NTIS HC A02/MF A01 CSCL 10A

The test procedures and the results obtained during the evaluation test program on the Solaron Corporation air-type solar collector are presented. The tests were performed under simulated conditions, following long-term exposure to natural weathering conditions. The Solaron Model 2001, air-type solar collector has a gross area of 19 square feet and the weight is 160 pounds. The absorber plate is made of 24-gage steel, the coating is baked-on black paint, the cover consists of two sheets of 1/8-inch low-iron tempered glass, and the insulation is one thickness of 3 5/8-inch fiberglass batting. L.S.

**N79-21622\*** General Electric Co., Wilmington, Mass. Aircraft Equipment Div.

# **SOLID POLYMER ELECTROLYTE (SPE) FUEL CELL TECHNOLOGY PROGRAM Final Report**

22 Mar. 1979 73 p

(Contract NAS9-15286)

(NASA-CR-160159; TPR-59) Avail: NTIS HC A04/MF A01 CSCL 10A

The overall objectives of the Phase IV Solid Polymer Electrolyte Fuel Cell Technology Program were to: (1) establish fuel cell life and performance at temperatures, pressures and current densities significantly higher than those previously demonstrated; (2) provide the ground work for a space energy storage system based on the solid polymer electrolyte technology (i.e., regenerative H2/O2 fuel cell); (3) design, fabricate and test evaluate a full-scale single cell unit. During this phase, significant progress was made toward the accomplishment of these objectives. G.Y.

**N79-21624\*** Army Facilities Engineering Support Agency, Fort Belvoir, Va.

# **ENERGY UTILIZATION SURVEY PAMPHLET FOR BUILDINGS Final Report**

Peter E. Baum and Harold D. Hollis 26 Apr. 1978 42 p refs

(AD-A062930; USAFESA-RT-2052)

Avail: NTIS HC A03/MF A01 CSCL 05/1

This pamphlet provides guidelines and forms to conduct an energy utilization survey of individual buildings and facilities on an installation. Forms are provided in this pamphlet for collection of information describing facility and individual building energy consumption. This information is needed to use energy conservation manuals which provide guidance on how to reduce and save energy through more effective operation of buildings and their mechanical and electrical systems, and through cost

effective retrofit of existing systems. A list of these manuals is provided in Appendix A. Author (GRA)

**N79-21625#** Versar, Inc., Springfield, Va.  
**ASSESSMENT OF COAL CLEANING TECHNOLOGY: AN EVALUATION OF CHEMICAL COAL CLEANING PROCESSES** Final Report, Apr. - Dec. 1977  
 G. Y. Contos, I. F. Frankel, and L. C. McCandless Aug. 1978 299 p refs  
 (Contract EPA-68-02-2199)  
 (PB-289493/9; EPA-600/7-78-173a) Avail: NTIS  
 HC A13/MF A01 CSCL 07A

Technical and economic information on chemical coal cleaning processes is assembled and assessed. Sufficient data was located to evaluate 11 processes in detail. It was found that chemical coal cleaning processes can remove up to 99% of the pyritic sulfur and 40% of the organic sulfur, resulting in total sulfur removals of 53 to 77%. This performance can be achieved with heat value recoveries of 57 to 96%. Processes which remove only pyritic sulfur were generally judged to have the highest probabilities of success. Of techniques which remove both pyritic and organic sulfur, the ERDA and GE microwave processes were judged to have the highest probabilities of success. GRA

**N79-21626#** Oklahoma Univ., Norman. Bureau of Water and Environmental Resources Research.  
**ENERGY CONSERVATION THROUGH SOURCE REDUCTION** Final Report  
 George W. Reid and Chan Hung Khuong Nov. 1978 76 p refs  
 (Grant EPA-R-804183)  
 (PB-290126/2; EPA-600/8-78-015) Avail: NTIS  
 HC A05/MF A01 CSCL 10A

Energy conservation through reduction in generation of post-consumer solid waste is reported. Output and input approaches to estimate the quantity and composition of post-consumer solid waste were reviewed. Estimates of energy consumed in the manufacture of discarded materials and in handling the solid waste are compiled. Potentials and possibilities of reducing refuse and estimates of corresponding energy savings were studied. Twenty examples of opportunities to reduce refuse at government, policy-maker, manufacturer, and consumer levels are proposed. The energy intensiveness of materials found in the waste stream, total energy residuals embedded in each material, and possible candidates for reduction with greatest energy savings are presented. GRA

**N79-21628#** California Energy Commission, Sacramento.  
**CONSERVATION WHERE IT COUNTS: ENERGY MANAGEMENT SYSTEMS** Final Report  
 Dick Foley Jan. 1978 14 p  
 (PB-289837/7; CAEC-002) Avail: NTIS HC A02/MF A01 CSCL 13A

This report aids managers of commercial buildings or industrial plants in identifying energy waste and controllable energy loads, and in choosing the right load control system for heating, ventilating, and air conditioning (HVAC) equipment. A method for calculating a building's energy budget is explained, and the U. S. General Services Administration energy budget guideline is given as a comparison. Energy saving equations are provided to help establish realistic energy waste reducing goals. Techniques for reducing the operating time of lights and HVAC equipment -- demand limit load shedding, optimization of equipment running time, fixed start-stop schedules, and load cycling -- are discussed. The various types of control equipment, from elaborate central mini-computer or micro-computer systems to simpler and less expensive programmable controllers or disburbed black box systems, are described, and approximate purchase costs are given. Checklists for comparing hardware costs are included. GRA

**N79-21630#** National Bureau of Standards, Washington, D. C. Building Economics and Regulatory Technology Div.  
**INTERIM PERFORMANCE CRITERIA FOR SOLAR HEATING**

# AND COOLING SYSTEMS IN RESIDENTIAL BUILDINGS, SECOND EDITION Final Report

John K. Holton Nov. 1978 113 p refs Sponsored in part by HUD  
 (PB-289967/2; NBSIR-78-1562) Avail: NTIS  
 HC A06/MF A01 CSCL 13A

The interim performance criteria, developed for the Department of Housing and Urban Development, are criteria and standards for the design, development, technical evaluation and procurement of the solar heating and cooling systems to be used in residential buildings during the solar heating and cooling demonstration program authorized by the Solar Heating and Cooling Demonstration Act of 1974. These interim criteria are intended primarily for use in the solar residential demonstration program and as a basis for the preparation of definitive performance criteria. GRA

**N79-21631#** NATO Committee on the Challenges of Modern Society, Brussels (Belgium).  
**REPORT OF THE 4TH CCMS (COMMITTEE ON THE CHALLENGES OF MODERN SOCIETY) SOLAR ENERGY PILOT STUDY MEETING**

Sheila Blum and Redfield W. Allen Aug. 1978 159 p Conf. held at Dusseldorf, Germany, 17-18 Apr. 1978 Prepared in cooperation with Maryland Univ., College Pk.  
 (Contract EY-76-S-05-4908)

(PB-289492/1; NATO/CCMS-84) Avail: NTIS  
 HC A08/MF A01 CSCL 10A

The cost effectiveness and practical application of solar energy to heating and cooling in buildings were examined. The final Solar Energy Pilot Study Meeting is summarized, and recommendations for continued international cooperation are made. Author

**N79-21632#** National Bureau of Standards, Washington, D. C. National Engineering Lab.  
**EXPERIMENTAL VERIFICATION OF A STANDARD TEST PROCEDURE FOR SOLAR COLLECTORS**

James E. Hill, John P. Jenkins, and Dennis E. Jones Jan. 1979 131 p refs Sponsored in part by DOE  
 (PB-289912/8; NBS-BSS-117; LC-78-600138) Avail: NTIS  
 HC A06/MF A01 CSCL 14B

A proposed procedure for testing and rating solar collectors based on thermal performance was published by the National Bureau of Standards (NBS) in 1974. The American Society of Heating, Refrigerating, and Air Conditioning (ASHRAE) developed a modified version of the NBS procedure which was adopted in early 1977 as ASHRAE Standard 93-77. A test facility for water-heating and air-heating collectors was built at NBS and was used to support the development of Standard 93-77. The recently adopted test procedure, the NBS test facility, and the tests that were conducted to support the development of the procedure are described. GRA

**N79-21640#** Oak Ridge National Lab., Tenn.  
**AN INVENTORY OF ENVIRONMENTAL IMPACT MODELS RELATED TO ENERGY TECHNOLOGIES**

P. T. Owen, ed., N. S. Dailey, ed., C. A. Johnson, ed., and F. M. Martin, ed. Feb. 1979 410 p  
 (Contract W-7405-eng-26)

(ORNL/EIS-147) Avail: NTIS HC A18/MF A01

An inventory is presented which identifies and collects data on computer simulations and computational models related to the environmental effects of energy source development, energy conversion, or energy utilization. In addition to the standard bibliographic information, other data fields of interest to modelers, such as computer hardware and software requirements, algorithms, applications, and existing model validation information, are included. Indexes are provided for contact persons, acronym, keyword, and title. The models are grouped into the following categories: atmospheric transport, air quality, aquatic transport, terrestrial food chain, soil transport, aquatic food chain, water quality, dosimetry and human effects, animal effects, plant effects, and generalized environmental transport. G.Y.

**N79-21661#** TRW, Inc., Durham, N. C.  
**EVALUATION OF DRY SORBENTS AND FABRIC FILTRATION FOR FGD (FLUE GAS DESULFURIZATION) Final Task Report, Mar. 1976 - Oct. 1978**

S. J. Lutz, R. C. Christman, B. C. McCoy, S. W. Mulligan, and K. M. Slimak Jan. 1979 155 p refs  
 (Contract EPA-68-02-2165)  
 (PB-289921/9; EPA-600/7-79-005) Avail: NTIS  
 HC A08/MF A01 CSCL 07A

The use of baghouses (fabric filtration) to control air pollutant emissions (particularly sulfur oxides) from large utility combustion sources was assessed. Sorbent costs, and system capital, operating, and disposal costs were determined. Sulfur dioxide would be removed by introducing powdered dry sorbent into the gas stream by precoating the baghouse fabric with sorbent. Whether the apparent economic advantage exhibited by the concept would remain intact after independent third-party evaluation, and if the economic (and other) advantages are sufficiently large to warrant further development of the process at field installations were evaluated. Results show that the dry sorbent baghouse FGD process exhibits an economic advantage when compared with current lime and limestone scrubbing technology when applied to Western power plants burning low sulfur coal. GRA

**N79-21662#** Radian Corp., Austin, Tex.  
**ENVIRONMENTAL ASSESSMENT: SOURCE TEST AND EVALUATION REPORT, CHAPMAN LOW-Btu GASIFICATION Final Task Report, Sep. 1977 - Sep. 1978**

Gordon C. Page Oct. 1978 257 p refs  
 (Contract EPA-68-02-2147)  
 (PB-289940/9; EPA-600/7-78-202) Avail: NTIS  
 HC A12/MF A01 CSCL 07A

The results of a source test and evaluation of a commercial Chapman low-Btu gasification facility are reported. The multimedia waste streams and potential fugitive emission and effluent streams from the facility were characterized. The applicability of Level 1 sampling and analytical methodology to such a characterization was evaluated. The particulate removal efficiency of the product gas cyclone was performed. Chemical and biological tests indicated that all multimedia waste and process streams examined contained potentially harmful organic and/or inorganic materials. The product gas cyclone was approximately 60% effective in removing particulate matter from the raw product gas stream. GRA

**N79-21670#** Environmental Protection Agency, Research Triangle Park, N.C. Monitoring and Data Analysis Div.  
**NATIONAL EMISSIONS DATA SYSTEMS (NEDS) FUEL USE REPORT (1975) Final Report**

Apr. 1978 130 p  
 (PB-290182/7; EPA-450/2-78-018) Avail: NTIS  
 HC A07/MF A01 CSCL 21D

This report summarizes annual estimates of total consumption of major fuels such as coal, fuel oil, natural gas, gasoline, and diesel fuel. Estimates of the consumption of a number of other comparatively minor fuels are also included. The data are distributed according to major categories of air pollutant emissions sources and are reported for the nation as a whole and for individual states, territories, and the District of Columbia. GRA

**N79-21671#** Hittman Associates, Inc., Columbia, Md.  
**AIR QUALITY IMPACTS USING SRC VERSUS CONVENTIONAL COAL IN POWER PLANTS Final Report, Nov. 1977 - Sep. 1978**

Irving Leichter, R. C. Koch, N. L. Nagda, and J. L. Swift Oct. 1978 356 p refs  
 (Contract EPA-68-02-2162)  
 (PB-290237/7; EPA-600/7-78-023) Avail: NTIS  
 HC A16/MF A01 CSCL 13B

The results of air quality modeling to assess the impact of burning solvent-refined coal (SRC) instead of conventional coal in three power plants which exceeded National Ambient Air Quality Standards when burning conventional coal are discussed. The EPA CRSTER Gaussian plume model with minor modifications was used to calculate ambient air pollution concentrations (for

SO<sub>2</sub>, NO<sub>x</sub>, and particulates) when (1) conventional coal and (2) SRC were burned. SRC test burn emissions data were used to determine emission factors for the three pollutants when burning SRC at each plant. The most significant impact of switching from conventional coal to SRC was the reduction of SO<sub>2</sub> and particulate concentrations at each plant. The highest 20 maximum 24-hour SO<sub>2</sub> concentrations were reduced by 60-75%. GRA

**N79-21679#** Argonne National Lab., Ill. Environmental Impact Studies Div.

**A BIOLOGIST'S MANUAL FOR THE EVALUATION OF IMPACTS OF COAL-FIRED POWER PLANTS ON FISH, WILDLIFE AND THEIR HABITATS**

B. G. Lewis, P. C. Chee, R. M. Goldstein, F. C. Kornegay, and D. L. Mabes Aug. 1978 226 p refs  
 (Contract W-31-109-eng-38)  
 (PB-291330/9; FWS/OBS-78/75) Avail: NTIS  
 HC A11/MF A01 CSCL 13B

This manual contains generalized summary of the major impacts to biota that are unique to coal-fired power plants. Power plant features and their impacts discussed in the manual include: gaseous and particulate stack emissions, coal slurry pipelines, coal cleaning and storage, limestone preparation and storage liquid effluents, solid wastes, and coal conversion. This manual, in conjunction with the detailed technical report, Impacts of Coal-Fired Power Plants on Fish, Wildlife, and Their Habitats; provides the information biologists need to have effective input to the power plant environment review process. GRA

**N79-21682#** Wahler (W. A.) and Associates, Palo Alto, Calif.  
**POLLUTION CONTROL GUIDELINES FOR COAL REFUSE PILES AND SLURRY PONDS Final Report, Dec. 1976 - Jul. 1977**

Nov. 1978 228 p refs  
 (Contracts EPA-68-03-2344; EPA-68-03-2431)  
 (PB-291369/7; EPA-600/7-78-222) Avail: NTIS  
 HC A11/MF A01 CSCL 08I

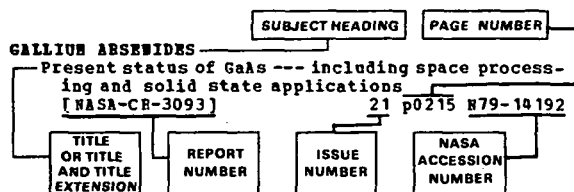
A large percentage of the eastern coal mined today is washed and processed to remove impurities and increase quality. The wastes from the preparation process pose a serious disposal problem. Acid and heavy refuse piles, suspended solids in waters from refuse areas and slurry ponds, noxious gases from oxidation and fires in refuse piles, and airborne particulates from dry exposed refuse surfaces were investigated. GRA

**N79-21689** Michigan Univ., Ann Arbor.  
**HEAT FLOW AND RADIOGENIC HEAT PRODUCTION IN BRAZIL WITH IMPLICATIONS FOR THERMAL EVOLUTION OF CONTINENTS Ph.D. Thesis**

Icaro Vitorello 1978 153 p  
 Avail: Univ. Microfilms Order No. 7907192  
 Heat flow and heat production results are reported from nineteen widely spaced sites in eastern and central parts of Brazil. Dissert. Abstr.

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## Typical Subject Index Listing



The subject heading is a key to the subject content of the document. The title or title and title extension provides the user with a brief description of the subject matter. The report number helps to indicate the type of document cited (e.g., NASA report, translation, NASA contractor report). The issue page and accession numbers are located beneath and to the right of the title e.g., 21 p0215 N79-14192. Under any subject heading the accession numbers are arranged in sequence with the IAA accession numbers appearing first.

## A

### ABSORBERS (MATERIALS)

Hydrogen absorption in rare earth intermetallic compounds 22 p0249 A79-21693

Solar energy application of natural zeolites --- solid absorber-water vapor working fluid system for sorption-refrigeration cycles 22 p0286 A79-27213

Optical design of a solar collector for the advanced solar thermal electric conversion/process heat program [Y/SUB-77/14261] 21 p0209 N79-13528

### ABSORPTANCE

Effect of surface curvature on measurement of the absorptance properties of solar coatings 21 p0042 A79-11879

### ABSORPTION

Absorption of hydrogen by the intermetallics NdNi5 and LaNi4Cu and a correlation of cell volumes and desorption pressures 21 p0038 A79-11804

Kinetics of hydrogen absorption and desorption --- for energy storage 22 p0248 A79-21687

### ABSORPTIVITY

The measurement of optical properties of selective surfaces using a solar calorimeter 21 p0041 A79-11874

Optimization studies on black chrome electroplating variables for solar selective surfaces 22 p0317 A79-31407

### ABSTRACTS

Energy information data base. Guide to abstracting and indexing [TID-4583-R1] 21 p0184 N79-11488

### AC GENERATORS

Status of free-piston Stirling engine/linear alternator power conversion system development 21 p0025 A79-10212

On the use of eddy-current couplings in wind-driven synchronous machines 21 p0113 A79-16742

Air Force applications of lightweight superconducting machinery --- in airborne power sources 22 p0290 A79-27666

### ACCELERATED LIFE TESTS

Accelerated tests for coatings --- for solar concentrators 22 p0296 A79-28668

Accelerated test program 22 p0370 N79-21577

### ACCUMULATORS

Problems in the development of high-service-life capacitive accumulators --- for fusion reactors 22 p0243 A79-21249

### ACIDITY

Factors affecting the open-circuit voltage and electrode kinetics of some iron/titanium/redox flow cells 21 p0040 A79-11824

### ACIDS

O2 reduction kinetics in concentrated acids --- in fuel cells 21 p0038 A79-11809

A state of charge monitor for sealed lead-acid cells [ATR-78(8114)-2] 21 p0220 N79-14558

### ACOUSTIC EMISSION

Study of acoustic and microseismic emissions associated with a hydraulic fracture --- geothermal energy utilization 21 p0076 A79-14744

Acoustic emissions during hydride formation 22 p0249 A79-21691

### ACOUSTIC MEASUREMENTS

Instrumentation for in situ coal gasification. IV - Seismic and acoustic techniques for remote monitoring 22 p0304 A79-29974

### ACUSTO-OPTICS

Photoacoustic determination of photovoltaic energy conversion efficiency 21 p0154 A79-18503

### ACTINIDE SERIES COMPOUNDS

Rare earth and actinide intermetallics as hydrogenation catalysts 22 p0251 A79-21713

### ACTIVATED CARBON

Influence of the electrolyte content of oxygen carbon gas-diffusion electrodes on their electro-chemical performance in acid solutions 22 p0245 A79-21483

Treatment of petroleum refinery, petrochemical and combined industrial-municipal wastewaters with activated carbon: Literature review [PB-288211/6] 22 p0350 N79-18497

### ACTIVATED SLUDGE

There is a lot of energy in digester gas . . . use it --- in municipal waste water plants 21 p0035 A79-11448

### ADAPTIVE CONTROL

Development of gas turbine performance seeking logic [ASME PAPER 78-GT-13] 21 p0031 A79-10257  
Conference on Decision and Control, and Symposium on Adaptive Processes, 16th, and Special Symposium on Fuzzy Set Theory and Applications, New Orleans, La., December 7-9, 1977, Proceedings. Volumes 1 & 2 21 p0081 A79-14957

### ADAPTIVE OPTICS

Non-adaptive optics for solar thermal electric power 21 p0112 A79-16733  
Historical review of adaptive optics technology 21 p0114 A79-17171

### ADDITIVES

Recent advances in electrocatalysis and their implications for fuel cells 21 p0038 A79-11807

Transparent conducting coatings for solar cells 21 p0124 A79-17350

Denaturants for ethanol/gasoline blends [HCP/M2098-01] 21 p0180 N79-11237

ADSORPTION

- Electrocatalysis, charge-transfer and the states of H adsorption in the hydrogen evolution reaction 21 p0038 A79-11801
- Treatment of petroleum refinery, petrochemical and combined industrial-municipal wastewaters with activated carbon: Literature review [PB-288211/6] 22 p0350 N79-18497

AERODYNAMIC CHARACTERISTICS

- A low cost blade design for a Darrieus-type vertical-axis wind turbine 21 p0067 A79-14291
- Some effects of flow curvature on the performance of Darrieus wind turbines [AIAA PAPER 79-0112] 21 p0156 A79-19538
- Fluid dynamics of diffuser-augmented wind turbines 22 p0238 A79-20798

AERODYNAMIC COEFFICIENTS

- An inverse problem of vertical-axis wind turbines 22 p0239 A79-20800

AERODYNAMIC CONFIGURATIONS

- Design, fabrication, and test of a composite material wind turbine rotor blade [NASA-CR-135389] 21 p0173 N79-10525

AERODYNAMIC DRAG

- An inverse problem of vertical-axis wind turbines 22 p0239 A79-20800

AEROELASTICITY

- Aeroelastic wind energy converter 21 p0047 A79-12275
- Aeroelastic response and stability of a coupled rotor/support system with application to large horizontal axis with turbines 22 p0332 N79-16346

AERONAUTICAL ENGINEERING

- The impact of aeronautical sciences on other modes of transport 22 p0325 A79-31915
- National Aeronautics and Space Act of 1958, as amended, and related legislation [GPO-34-175] 21 p0214 N79-13932
- The AGARD propulsion and energetics panel, 1952-1977 [AGARD-AR-111] 22 p0337 N79-16848

AEROSOLS

- The oxidation of sulfur dioxide to sulfate aerosols in the plume of a coal-fired power plant 21 p0076 A79-14757
- The circumsolar measurement program - Assessment of the effects of atmospheric scattering on solar energy conversion 21 p0082 A79-15077
- Trace element emissions from coal-fired power plants [ASME PAPER 78-WA/FU-9] 21 p0160 A79-19789
- Differential insolation and turbidity measurements --- solar radiation attenuation by aerosols 22 p0241 A79-21056
- Study of solid-gas-suspensions used for direct absorption of concentrated solar radiation 22 p0262 A79-23757
- Elemental characteristics of aerosols emitted from a coal-fired heating plant [NASA-TM-78749] 21 p0191 N79-11560

AEROSPACE ENGINEERING

- Energy and aerospace; Proceedings of the Anglo-American Conference, London, England, December 5-7, 1978 22 p0325 A79-31908
- FY 1978 scientific and technical reports, articles, papers, and presentations --- bibliography [NASA-TM-78203] 21 p0214 N79-13915
- OAST Space Theme Workshop. Volume 1: Summary report. 1: Introduction. 2: General observations and some key findings. 3: Follow-on activity. Quick-look comments and working papers [NASA-TM-80001] 21 p0224 N79-15113

AEROSPACE ENVIRONMENTS

- Optics in adverse environments; Proceedings of the Seminar, San Diego, Calif., August 25, 26, 1977 21 p0044 A79-12037

AEROSPACE INDUSTRY

- International Instrumentation Symposium, 24th, Albuquerque, N. Mex., May 1-5, 1978, Proceedings. Parts 1 & 2 21 p0144 A79-17576

AEROSPACE MEDICINE

- Health maintenance and health surveillance considerations for an SPS space construction base community [AAS PAPER 78-176] 22 p0243 A79-21273

AEROSPACE SCIENCES

- Some perspectives on research into the biological response to non-ionizing electromagnetic radiation --- relation to SETI, SPS, and other government projects 22 p0271 A79-24879

- Technology assessment, volume 2. A bibliography with abstracts [NTIS/PS-78/0830/6] 21 p0179 N79-10951

- FY 1978 scientific and technical reports, articles, papers, and presentations --- bibliography [NASA-TM-78203] 21 p0214 N79-13915

- Symposium on the Future of Space Science and Space Applications [GPO-23-876] 21 p0224 N79-15105

AEROSPACE SYSTEMS

- Future large space systems opportunities: A case for space-to-space power? --- spacecraft power supplies microwave and laser transmission 21 p0169 N79-10095

AEROSPACE TECHNOLOGY TRANSFER

- Activities in the field of solar cells in the Federal Republic of Germany 21 p0056 A79-13636
- Current and potential uses of aerospace technology by the U.S. Department of the Interior [AIAA PAPER 78-1716] 21 p0060 A79-13833
- Space Congress, 15th, Cocoa Beach, Fla., April 26-28, 1978, Proceedings 21 p0099 A79-16126
- The Solar Heating and Cooling Commercial Demonstration Program at Marshall Space Flight Center - Some problems and conclusions 21 p0099 A79-16135
- Selective application of materials for products and energy; Proceedings of the Twenty-third National Symposium and Exhibition, Anaheim, Calif., May 2-4, 1978 22 p0239 A79-20801
- The Energy Research and Development Program of the United States 22 p0325 A79-31909

AGE FACTOR

- The effect of maturation on the configuration of pristane in sediments and petroleum 22 p0272 A79-25375

AGING (MATERIALS)

- Catalyst aging tests and the role of catalyst wetting on hydrosulfurization of a coal derived liquid 22 p0352 N79-19169
- Aging behavior of crude shale oil [AD-A062420] 22 p0357 N79-20272

AGITATION

- Design of a direct wind energy converter to heat water by agitation in a closed tank 21 p0067 A79-14290

AGRICULTURE

- Compartmental model for agricultural conversion of solar energy into fixed biomass 21 p0022 A79-10181
- Potential agricultural uses of fluidized bed combustion waste 21 p0064 A79-14108
- Environmental factors affecting the installation and operation of gas turbine engines in agricultural aircraft [SAE PAPER 781010] 22 p0274 A79-25892
- Field tests of photovoltaic power systems [ASME PAPER 79-SOL-10] 22 p0308 A79-30545
- Preliminary environmental assessment of energy conversion processes for agricultural and forest product residues, volume 1 [PB-281189/1] 21 p0178 N79-10574
- Multidisciplinary research related to the atmospheric sciences [PB-283076/8] 21 p0179 N79-10679
- Solar irrigation program plan: Second revision [SAND-78-0308-REV] 21 p0187 N79-11525
- Applying NASA remote sensing data to geologically related regional planning problems in Tennessee [E79-10095] 22 p0339 N79-17289



## SUBJECT INDEX

## AIR FLOW

- AIR**  
Reducing combustion air temperature variations in magnetohydrodynamic/steam power plants 21 p0016 A79-10135
- AIR CARGO**  
Public policy 21 p0179 A79-11011
- AIR CONDITIONING**  
Liquid desiccant solar air conditioner and energy storage system 21 p0021 A79-10176  
Simulations of the performance of open cycle desiccant systems using solar energy 21 p0066 A79-14262  
A solar energy system for space heating and space cooling --- retrofitting aged buildings 21 p0072 A79-14686  
Barriers and incentives to the commercialization of solar heating and cooling of buildings 21 p0072 A79-14687  
Heat recovery devices for building HVAC systems --- Heating Ventilating and Air Conditioning 21 p0073 A79-14697  
Instrumentation, data acquisition and monitoring system for an air heating solar system 21 p0088 A79-15836  
Moderate cost, calculator-based data acquisition for solar HVAC systems 21 p0088 A79-15837  
Boosting the performance of solar HVAC systems by improving component interactions --- Heating, Ventilating and Air Conditioning 21 p0089 A79-15851  
Using controls to reduce component size and energy needs for solar HVAC --- Heating Ventilating, Air Conditioning 21 p0102 A79-16421  
The El Camino Real Solar Cooling Demonstration Project 21 p0102 A79-16425  
Stochastic simulation experiments on solar air conditioning systems 21 p0138 A79-17474  
Simulation and design of evacuated tubular solar residential air conditioning systems and comparison with actual performance 21 p0138 A79-17475  
An experimental evaluation of an intermittent cycle solar-powered ammonia/water absorption air conditioning system 21 p0139 A79-17481  
Solar heated and cooled financial building 21 p0139 A79-17484  
System performance predictions for solar cooling using regional stochastic weather models 22 p0264 A79-23781  
Solar heating and cooling performance of the Los Alamos National Security and Resources Study Center 22 p0277 A79-25944  
Solid desiccant air conditioning with silica gel using solar energy 21 p0181 A79-11464  
Plan for the development and implementation of standards for solar heating and cooling applications [PB-283237/6] 21 p0190 A79-11543  
Solar Heating And Cooling Of Buildings (SHACOB) commercialization report. Part A: Options and strategies. Volume 1: Executive summary [HCP/H70065-01/1] 21 p0207 A79-13512  
Solar Heating And Cooling Of Buildings (SHACOB) commercialization report. Part B: Analysis of market development, volume 2 [HCP/H70066-01/2] 21 p0207 A79-13513  
Solar space heating and air conditioning, volume 2. Citations from the NTIS data base [NTIS/PS-78/1014/6] 21 p0211 A79-13545  
Solar space heating and air conditioning volume 3. Citations from the NTIS data base [NTIS/PS-78/1015/3] 21 p0211 A79-13546  
Solar space heating and air conditioning, volume 3. Citations from the engineering index data base [NTIS/PS-78/1017/9] 21 p0211 A79-13547  
Preliminary design package for prototype solar heating and cooling systems [NASA-CR-150853] 21 p0229 A79-15409  
Environmental and safety considerations for solar heating and cooling applications [PB-287772/8] 22 p0343 A79-17350  
Buildings energy use data book, edition 1 [ORNL-5363] 22 p0348 A79-18447  
The updated algorithms of the Energy Consumption Program (ECP): A computer model simulating heating and cooling energy loads in buildings 22 p0351 A79-19059  
Preliminary design package for residential heating/cooling system: Rankine air conditioner redesign [NASA-CR-150871] 22 p0354 A79-19453  
A fixed tilt solar collector employing reversible vee-through reflectors and evaluated tube receivers for solar heating and cooling systems [NASA-CR-158420] 22 p0359 A79-20490  
An analytical investigation of the performance of solar collectors as nighttime heat radiators in airconditioning cycles [NASA-CR-3111] 22 p0363 A79-20519  
Solar energy pilot study [PB-289380/8] 22 p0363 A79-20525  
Interim performance criteria for solar heating and cooling systems in residential buildings, second edition [PB-289967/2] 22 p0372 A79-21630
- AIR CONDITIONING EQUIPMENT**  
Solar heating and ventilating by natural means 21 p0103 A79-16458  
Theoretical basis and design for a residential size solar powered ammonia/water absorption air conditioning system 21 p0139 A79-17479  
Performance predictions of a LiBr absorption air conditioner utilizing solar energy 21 p0139 A79-17482  
Heat pump technology for saving energy --- Book 22 p0302 A79-29624  
Solar Rankine engines - Examples and projected costs [ASME PAPER 79-SOL-3] 22 p0307 A79-30541  
Optimum dry-cooling sub-systems for a solar air conditioner [NASA-TM-79007] 21 p0183 A79-11477  
Solar evacuated tube collector: Absorption chiller systems simulation [COO-2577-13] 21 p0209 A79-13530  
Candidate chemical systems for air cooled, solar powered, absorption air conditioner design. Part 2: Solid absorbents, high latent heat refrigerants [SAN/1587-2] 21 p0211 A79-13544
- AIR COOLING**  
Design data brochure for the Owens-Illinois Sunpak (TM) air-cooled solar collector [NASA-CR-150868] 21 p0229 A79-15404
- AIR DUCTS**  
Hybrid air to water solar collector design 21 p0021 A79-10174  
Tropospheric conduits --- for pollution abatement and energy production 22 p0266 A79-24275
- AIR FILTERS**  
Particulate control for coal-fired industrial boilers 21 p0065 A79-14123  
Gas turbine operating and maintenance experience in Saudi Arabia 22 p0298 A79-28989  
Evaluation of dry sorbents and fabric filtration for PGD (Flue Gas Desulfurization) [PB-289921/9] 22 p0373 A79-21661
- AIR FLOW**  
Progress in the testing of materials and design concepts for directly-fired MHD air heater service 21 p0017 A79-10141  
Return flow solar air-heater 21 p0055 A79-13609  
The application of ASHRAE Standard 93-77 to the thermal performance testing of air solar collectors 21 p0102 A79-16423  
Cheap packed bed absorbers for solar air heaters 21 p0128 A79-17388  
Effect of buoyancy and tube inclination on heat transfer in a solar air heater 21 p0129 A79-17402

# AIR INTAKES

# SUBJECT INDEX

An air-modulated fluidic fuel-injection system --- automobile fuel management  
[ASME PAPER 78-WA/DSC-21] 21 p0159 A79-19766

Measured air flow rates through microorifices and flow prediction capability  
[PB-286868/5] 21 p0217 W79-14344

## AIR INTAKES

Investigation of turbo-dyne energy chamber (G:R: value trademark): An air bleed device  
[PB-285381/0] 21 p0217 W79-14397

## AIR JETS

The theoretical analysis of an air turbine generation system --- for waterwave energy conversion.  
21 p0151 A79-18106

## AIR POLLUTION

Factors limiting limestone utilization efficiency in fluidized-bed combustors --- in determining sulfur dioxide emission level  
21 p0008 A79-10069

Controlling NOx from a coal-fired MHD process  
21 p0017 A79-10139

Alternative fuels and combustion problems  
21 p0051 A79-12978

Use of alternative fuels in stationary combustors  
21 p0052 A79-12981

Role of aromatics in soot formation  
21 p0053 A79-12988

Emission control techniques for alternative fuel combustion  
21 p0053 A79-12990

State-of-the-art assessment of air pollution control technologies for various waste-as-fuel processes  
21 p0064 A79-14111

Energy consumption of environmental controls - Fossil fuel, steam electric generating industry  
21 p0064 A79-14112

Ambient air quality assessment of the Synthane coal gasification pilot plant, six month study /August 1976-January 1977/  
21 p0064 A79-14113

Particulate control for coal-fired industrial boilers  
21 p0065 A79-14123

The direct reduction of sulfur dioxide  
21 p0065 A79-14124

The impact of a coal fired power plant on ambient sulfur dioxide levels  
21 p0082 A79-15032

On the depletion of ambient ozone by a rural coal-fired power plant near Portage, Wisconsin  
21 p0082 A79-15052

Source emissions factors for refuse derived fuels  
21 p0082 A79-15084

Shock tube studies of coal devolatilization  
21 p0083 A79-15247

Particulate and sulfur oxide control options for conventional coal combustion  
21 p0092 A79-15883

Coal-based electricity and air pollution control - A case for solvent refined coal  
21 p0096 A79-15922

Commercialization of fluidized-bed combustion systems by the State of Ohio  
21 p0096 A79-15923

Clean Air Act amendments of 1977 and the impact on control efforts  
21 p0097 A79-16091

Motor vehicle lead emissions in the United States - An analysis of important determinants, geographic patterns and future trends  
21 p0113 A79-16745

Reducing inefficiency and emissions of large steam generators in the United States  
21 p0114 A79-17075

An analysis of air pollution control costs in N.S.W. --- New South Wales, Australia  
21 p0115 A79-17228

Advanced emissions control and test facility of the Electric Power Research Institute  
21 p0115 A79-17249

The fate of trace elements in coal after combustion  
21 p0116 A79-17250

The influence of lead compounds on automotive exhaust catalysts  
21 p0116 A79-17253

Assessment of current flue gas desulfurization technology  
21 p0145 A79-17637

A survey of particulate collection devices for coal-fired boilers  
21 p0147 A79-17645

Emission control for SO2 - An update  
[ASME PAPER 78-JPGC-PWR-11] 21 p0150 A79-18097

Operating experience with three 20 MW prototype flue gas desulfurization processes  
[ASME PAPER 78-JPGC-PWR-12] 21 p0150 A79-18098

Emissions of nitrogen dioxide from a large gas-turbine power station  
21 p0152 A79-18344

The measurement of the sulfuric acid and sulfate content of particulate matter resulting from the combustion of coal and oil  
21 p0156 A79-19219

Real-time, continuous measurement of automotive sulfuric acid emissions  
21 p0156 A79-19359

Operation and emission of a stoker-fired boiler while burning refuse derived fuel and coal mixtures  
[ASME PAPER 78-WA/APC-2] 21 p0158 A79-19735

Modification of electrostatic precipitator performance by use of fly-ash conditioning agents  
[ASME PAPER 78-WA/APC-3] 21 p0158 A79-19736

Combustion modifications for the control of air pollutant emissions from coal fired utility boilers  
[ASME PAPER 78-WA/APC-7] 21 p0158 A79-19738

Tests of various coals, coal-oil mixtures and refuse derived fuels in an experimental test facility  
[ASME PAPER 78-WA/APC-12] 21 p0158 A79-19741

Combustion modification pollutant control techniques for industrial boilers - The influence of fuel oil properties and atomization parameters  
[ASME PAPER 78-WA/APC-13] 21 p0159 A79-19742

Tropospheric conduits --- for pollution abatement and energy production  
22 p0266 A79-24275

Oxidation of SO2 on the surface of fly ash particles under low relative humidity conditions  
22 p0277 A79-26038

Electrostatic precipitation tests with fuel oil ash  
22 p0296 A79-28390

Electric car project of the Eindhoven University of Technology  
22 p0302 A79-29498

The application of indirectly fired open cycle gas turbine systems utilizing atmospheric pressure fluidized bed combustors to industrial cogeneration situations  
[ASME PAPER 79-GT-16] 22 p0306 A79-30510

Chemical studies of stack fly ash from a coal-fired power plant  
22 p0309 A79-30595

Emissions and economy potential of prechamber stratified charge engines  
[SAE PAPER 790436] 22 p0315 A79-31374

A new combustion system in the three-valve stratified charge engine  
[SAE PAPER 790439] 22 p0316 A79-31376

Particulate and sulfur dioxide emission control costs for large coal-fired boilers  
[PB-281271/7] 21 p0178 W79-10591

Particulate control mobile test units: Third year's operation  
[PB-283657/5] 21 p0178 W79-10603

Low NOx combustion concepts for advanced power generation systems firing low-Btu gas  
[PB-282983/6] 21 p0178 W79-10610

Elemental characteristics of aerosols emitted from a coal-fired heating plant  
[NASA-TM-78749] 21 p0191 W79-11560

National Emissions Data System (NEDS) fuel use report (1974)  
[PB-284658/2] 21 p0194 W79-12251

Nitrogen oxide air pollution. Volume 2, part 1: Control technology. A bibliography with abstracts  
[NTIS/PS-78/0971/8] 21 p0199 W79-12591

Nitrogen oxide air pollution. Part 3: Atmospheric chemistry. A bibliography with abstracts  
[NTIS/PS-78/0973/4] 21 p0199 W79-12593

- Evaluations of novel particulate control devices  
[PB-283973/6] 21 p0199 N79-12601
- Regional air pollution study: Heat emission inventory  
[PB-284081/7] 21 p0200 N79-12602
- Environmental effects of increased coal utilization ecological effects of gaseous emission from coal combustion  
[PB-285440/4] 21 p0213 N79-13591
- Investigation of turbo-dyne energy chamber (G:R: value trademark): An air bleed device  
[PB-285381/0] 21 p0217 N79-14397
- Evaluation of electrostatic precipitator during SRC combustion tests  
[PB-285864/5] 21 p0223 N79-14618
- Analysis of radioactive contaminants in by-products from coal-fired power plant operations  
[PB-286365/2] 21 p0232 N79-15473
- Combustion research on the fate of fuel-nitrogen under conditions of pulverized coal combustion  
[PB-286208/4] 21 p0232 N79-15474
- Assessment of coal cleaning technology  
[PB-287091/3] 22 p0330 N79-16139
- Environmental assessment for residual oil utilization  
[PB-286982/4] 22 p0336 N79-16446
- Combustion of hydrothermally treated coals  
[PB-287521/9] 22 p0338 N79-17025
- Pollutants from synthetic fuels production: Facility construction and preliminary tests --- coal gasification plant effluents  
[PB-287730/6] 22 p0339 N79-17027
- Low-sulfur western coal use in existing small and intermediate size boilers --- particulate sampling and combustion efficiency  
[PB-287937/7] 22 p0346 N79-18061
- Source assessment: Open mining of coal. State of the Art  
[PB-288497/1] 22 p0353 N79-19429
- Effects of low ambient temperature on the exhaust emissions and fuel economy of 84 automobiles in Chicago  
[PB-288400/5] 22 p0355 N79-19488
- Assessment of coal cleaning technology: An evaluation of chemical coal cleaning processes  
[PB-289493/9] 22 p0372 N79-21625
- Environmental assessment: Source test and evaluation report, Chapman low-Btu gasification  
[PB-289940/9] 22 p0373 N79-21662
- National Emissions Data Systems (NEDS) fuel use report (1975)  
[PB-290162/7] 22 p0373 N79-21670
- Air quality impacts using SRC versus conventional coal in power plants  
[PB-290237/7] 22 p0373 N79-21671
- AIR QUALITY**
- Ambient air quality assessment of the Synthane coal gasification pilot plant, six month study /August 1976-January 1977/  
21 p0064 A79-14113
- Clean Air Act amendments of 1977 and the impact on control efforts  
21 p0097 A79-16091
- A methodology for assessing the potential impact on air quality resulting from geothermal resource development in the Imperial Valley  
21 p0116 A79-17262
- Air quality assessment of particulate emissions from diesel-powered vehicles  
[PB-286172/2] 21 p0223 N79-14641
- Environmental conservation concerns in transportation: Energy, noise, and air quality  
[PB-286550/9] 21 p0232 N79-15868
- Air quality impacts using SRC versus conventional coal in power plants  
[PB-290237/7] 22 p0373 N79-21671
- AIR TRAFFIC CONTROL**
- Simulation study of the effect of fuel-conservative approaches on ATC procedures and terminal area capacity  
[SAE PAPER 780523] 21 p0031 A79-10398
- Procedure for flight guidance in the terminal maneuvering area for an experimental program employing a flying test device  
21 p0147 A79-17680
- Dynamic simulation studies of fuel conservation procedures used in terminal areas  
22 p0259 A79-23581
- AIR TRANSPORTATION**
- Energy conservation aircraft design and operational procedures  
[ONERA, TP NO. 1978-107] 21 p0036 A79-11572
- Alternate aircraft fuels prospects and operational implications  
21 p0066 A79-14138
- Rule of fuel management --- for airlines  
21 p0155 A79-18521
- The Sunship --- solar powered airship design  
22 p0254 A79-22324
- Advanced air transport concepts --- review of design methods for very large aircraft  
22 p0312 A79-31121
- The impact of aeronautical sciences on other modes of transport  
22 p0325 A79-31915
- AIR WATER INTERACTIONS**
- A cost effective vertical air/water solar heating collector  
22 p0320 A79-31430
- AIRBORNE EQUIPMENT**
- Surtrace - An airborne geochemical system --- for earth surface micro-layer exploration  
22 p0255 A79-22557
- Infrared remote sensing on geothermal areas by helicopter  
22 p0256 A79-22628
- AIRBORNE/SPACEBORNE COMPUTERS**
- Fuel conservative subsonic transport --- control surfaces activated by computers  
22 p0337 A79-16674
- AIRCRAFT CONSTRUCTION MATERIALS**
- Behavior of nonmetallic materials in shale oil derived jet fuels and in high aromatic and high sulfur petroleum fuels --- compatibility of aircraft materials to fuels  
[AD-A060322] 21 p0226 N79-15203
- AIRCRAFT DESIGN**
- Energy conservation aircraft design and operational procedures  
[ONERA, TP NO. 1978-107] 21 p0036 A79-11572
- Pilot's view of the evolving air transport  
21 p0053 A79-13885
- Technology for aircraft energy efficiency  
21 p0066 A79-14136
- The improved rigid airship --- design characteristics and cost analysis  
21 p0086 A79-15572
- Recent advances in convectively cooled engine and airframe structures for hypersonic flight  
21 p0165 A79-20087
- Very large vehicles - To be or --- aircraft design concepts  
22 p0306 A79-30484
- Large-vehicle concepts --- aircraft design  
22 p0306 A79-30485
- Advanced air transport concepts --- review of design methods for very large aircraft  
22 p0312 A79-31121
- Prospects for reducing the fuel consumption of civil aircraft  
22 p0325 A79-31911
- The NASA Aircraft Energy Efficiency program  
22 p0325 A79-31912
- Vehicle Design Evaluation Program (VDEP). A computer program for weight sizing, economic, performance and mission analysis of fuel-conservative aircraft, multibodied aircraft and large cargo aircraft using both JP and alternative fuels  
[NASA-CR-145070] 21 p0200 N79-13026
- Energy conservation aircraft design and operational procedures  
21 p0202 N79-13200
- An analysis of fuel conserving operational procedures and design modifications for bomber/transport aircraft. Volume 1: Executive summary  
[AD-1061746] 22 p0351 N79-18960
- AIRCRAFT ENGINES**
- Powerplant integration - The application of current experience to future developments  
[ASME PAPER 78-CT-113] 21 p0032 A79-10788
- Making turbofan engines more energy efficient  
[ASME PAPER 78-CT-198] 21 p0033 A79-10818
- Impact of future fuel properties on aircraft engines and fuel systems  
21 p0036 A79-11600

# AIRCRAFT EQUIPMENT

# SUBJECT INDEX

Automotive engines - A viable alternative for aircraft 21 p0047 A79-12379

Turbine engines in light aircraft 21 p0047 A79-12380

Current problems in the development and production of small gas turbine engines 21 p0048 A79-12529

Laser aircraft propulsion 21 p0109 A79-16610

Laser-powered aircraft and rocket systems with laser energy relay units 21 p0109 A79-16619

Fuel conservative aircraft engine technology 21 p0164 A79-20078

Engine technology for production turbofan engines 22 p0270 A79-24827

Effect of broadened-specification fuels on aircraft engines and fuel systems [AIAA 79-7008] 22 p0300 A79-29383

The NASA Aircraft Energy Efficiency program 22 p0325 A79-31912

Energy efficient engine preliminary design and integration study [NASA-CR-135396] 21 p0194 A79-12084

Aircraft Engine Future Fuels and Energy Conservation [AGARD-LS-96] 21 p0201 A79-13192

Future fuels for aviation 21 p0201 A79-13193

The role of fundamental combustion in the future aviation fuels program --- carbon formation in gas turbine primary zones 21 p0202 A79-13195

Impact of future fuel properties on aircraft engines and fuel systems 21 p0202 A79-13197

Engine component improvement and performance retention 21 p0202 A79-13198

Low energy consumption engines 21 p0202 A79-13199

The rotary combustion engine: A candidate for general aviation --- conferences [NASA-CP-2067] 22 p0329 A79-15961

General aviation energy-conservation research programs 22 p0329 A79-15963

Development status of rotary engine at Toyo Kogyo --- for general aviation aircraft 22 p0329 A79-15964

Update of development on the new Audi NSU rotary engine generation --- for application to aircraft engines 22 p0329 A79-15965

Review of the Rhein-Flugzeugbau Wankel powered aircraft program --- ducted fan engines 22 p0329 A79-15966

Rotary engine developments at Curtiss-Wright over the past 20 years and review of general aviation engine potential --- with direct chamber injection 22 p0329 A79-15967

Engine requirements for future general aviation aircraft 22 p0329 A79-15968

Effect of broadened-specification fuels on aircraft engines and fuel systems [NASA-TN-79086] 22 p0330 A79-16136

**AIRCRAFT EQUIPMENT**

Air Force applications of lightweight superconducting machinery --- in airborne power sources 22 p0290 A79-27666

Nickel-zinc battery for aircraft and missile applications [AD-A059295] 21 p0220 A79-14561

**AIRCRAFT FUEL SYSTEMS**

Effect of broadened-specification fuels on aircraft engines and fuel systems [NASA-TN-79086] 22 p0330 A79-16136

**AIRCRAFT FUELS**

Simulation study of the effect of fuel-conservative approaches on ATC procedures and terminal area capacity [SAE PAPER 780523] 21 p0031 A79-10398

Advanced turbofan engines for low fuel consumption [ASME PAPER 78-GT-192] 21 p0033 A79-10816

Alternative aircraft fuels 21 p0033 A79-10824

Some aspects of aircraft jet engine fuels 21 p0035 A79-11368

Characteristics and combustion of future hydrocarbon fuels 21 p0036 A79-11599

Alternative aviation turbine fuels 21 p0047 A79-12378

Impact of fuel availability and other cost trends on air carrier operations 21 p0053 A79-13077

Impact of fuel availability and other cost trends on general aviation 21 p0053 A79-13078

Alternate aircraft fuels prospects and operational implications 21 p0066 A79-14138

Selection of a characteristic quantity defining the self-ignition of a fuel in a stream 21 p0114 A79-16786

Rule of fuel management --- for airlines 21 p0155 A79-18521

A characteristic time correlation for combustion inefficiency from alternative fuels [AIAA PAPER 79-0357] 21 p0158 A79-19687

Drag reduction by cooling in hydrogen fueled aircraft 21 p0165 A79-20084

The potential of liquid hydrogen as a military aircraft fuel 22 p0238 A79-20773

Effects of fuel properties on soot formation in turbine combustion [SAE PAPER 781026] 22 p0274 A79-25899

Shale oil - The answer to the jet fuel availability question [SAE PAPER 781027] 22 p0274 A79-25900

Laser aircraft --- using kerosene 22 p0284 A79-26597

Cryohydrogen-fuel for tomorrow's commercial aircraft 22 p0289 A79-27656

High-freezing-point fuels used for aviation turbine engines [ASME PAPER 79-GT-141] 22 p0309 A79-30555

Analytical evaluation of the impact of broad specification fuels on high bypass turbofan engine combustors [NASA-CR-159454] 21 p0200 A79-13050

Effect of broadened-specification fuels on aircraft engines and fuel systems [NASA-TN-79086] 22 p0330 A79-16136

Alternative hydrocarbon fuels: Combustion and chemical kinetics --- synthetic aircraft fuels [AD-A061050] 22 p0338 A79-17011

Study of hydrogen recovery systems for gas vented while refueling liquid-hydrogen fueled aircraft [NASA-CR-158991] 22 p0346 A79-18057

**AIRCRAFT GUIDANCE**

Procedure for flight guidance in the terminal maneuvering area for an experimental program employing a flying test device 21 p0147 A79-17680

**AIRCRAFT INSTRUMENTS**

Flying angle of attack 21 p0048 A79-12384

**AIRCRAFT SPECIFICATIONS**

Effect of broadened-specification fuels on aircraft engines and fuel systems [AIAA 79-7008] 22 p0300 A79-29383

**AIRFOIL PROFILES**

The influence of blade camber on the output of vertical-axis wind turbines 21 p0045 A79-12242

A low cost blade design for a Darrieus-type vertical-axis wind turbine 21 p0067 A79-14291

Airfoil data for use of wind turbine designers 21 p0073 A79-14702

Diffuser designs for improved wind energy conversion 22 p0279 A79-26182

**AIRFOILS**

Airfoil data for use of wind turbine designers 21 p0073 A79-14702

**AIRFRAMES**

Recent advances in convectively cooled engine and airframe structures for hypersonic flight 21 p0165 A79-20087

**AIRLINE OPERATIONS**

Economy in flight operations 21 p0048 A79-12383

# SUBJECT INDEX

# ALUMINUM ALLOYS

- Impact of fuel availability and other cost trends on air carrier operations 21 p0053 A79-13077
- Rule of fuel management --- for airlines 21 p0155 A79-18521
- Dynamic simulation studies of fuel conservation procedures used in terminal areas 22 p0259 A79-23581
- AIRPORT PLANNING**
  - Simulation study of the effect of fuel-conservative approaches on ATC procedures and terminal area capacity [SAE PAPER 780523] 21 p0031 A79-10398
- AIRSHIPS**
  - The improved rigid airship --- design characteristics and cost analysis 21 p0086 A79-15572
  - The Sunship --- solar powered airship design 22 p0254 A79-22324
- ALASKA**
  - Non-electric applications of geothermal energy in six Alaskan towns [ADO-1622-4] 21 p0208 A79-13523
  - Northern Alaska hydrocarbon resources [PB-287394/1] 22 p0332 A79-16342
  - Environmental assessment of the Alaskan Continental Shelf. Volume 1: Biological studies [PB-289154/7] 22 p0344 A79-17366
  - Environmental assessment of the Alaskan Continental Shelf. Volume 2: Biological studies [PB-289155/4] 22 p0344 A79-17367
  - Environmental assessment of the Alaskan Continental Shelf. Volume 3: Biological studies [PB-289156/2] 22 p0344 A79-17368
  - Marine biological effects of OCS petroleum development [PB-288935/0] 22 p0344 A79-17374
- ALCOHOLS**
  - The status of alcohol fuels utilization technology for highway transportation 21 p0003 A79-10035
  - Alcohol fuels program plan [DOE/US-0001/2] 21 p0180 A79-11242
  - Status of alcohol fuels utilization technology for highway transportation [NCP/2923-01] 21 p0201 A79-13190
- ALGAE**
  - Organic geochemical studies on kerogen precursors in recently deposited algal mats and oozes 21 p0031 A79-10419
  - The economics and engineering of large-scale algae biomass energy systems [PB-287868/4] 21 p0226 A79-15207
  - Photoproduction of hydrogen by marine blue-green algae [PB-287508/6] 22 p0343 A79-17354
- ALGORITHMS**
  - The use and limitations of ASHRAE solar algorithms in solar energy utilization studies 21 p0101 A79-16416
  - Use of monolithic structures for the short term storage of solar energy 21 p0121 A79-17327
  - Non-linear numerical algorithms for studying tearing modes --- in tokamaks 22 p0257 A79-22981
  - The updated algorithms of the Energy Consumption Program (ECP): A computer model simulating heating and cooling energy loads in buildings 22 p0351 A79-19059
- ALIGNMENT**
  - Five MW solar thermal test facility heliostat focus and alignment system 21 p0043 A79-11972
  - A simple solar tracking system --- manually adjusted rotating shaft for solar concentrator positioning 21 p0136 A79-17457
  - Microwave systems analysis, solar power satellite --- alignment of the antenna array [NASA-CR-160091] 22 p0337 A79-16892
- ALKALI METALS**
  - Ionizing seed --- for open cycle MHD power generation 21 p0106 A79-16490
  - Absorption of solar radiation by alkali vapors --- for efficient high temperature energy converters 21 p0108 A79-16612
- The electric conductivity of a plasma of combustion products of hydrocarbon fuels with alkali impurity 21 p0167 A79-20415
- ALKALIES**
  - Catalytic coal gasification exploratory research program 21 p0030 A79-10247
  - Advanced electrolysis in alkaline solution --- for hydrogen production 21 p0037 A79-11798
- ALKALINE BATTERIES**
  - Development and evaluation of a 600-kWh lithium-hydrogen peroxide reserve power system 21 p0011 A79-10095
  - An improved method for analysis of hydroxide and carbonate in alkaline electrolytes containing zinc 21 p0035 A79-11546
  - The zinc electrode in sealed alkaline cells 21 p0040 A79-11823
  - Electrochemical determinations of the chemical potential and diffusivity of sodium in Na/x/TaS<sub>2</sub> at 300 K 21 p0040 A79-11830
  - Recent developments in power sources with special emphasis on alkaline batteries --- for electric vehicles 22 p0301 A79-29490
- ALKANES**
  - Combustion chemistry of chain hydrocarbons 21 p0052 A79-12986
  - The effect of maturation on the configuration of pristane in sediments and petroleum. 22 p0272 A79-25375
  - The preparation of some novel electrolytes: Synthesis of partially fluorinated alkane sulfonic acids as potential fuel cell electrolytes [AD-A056278] 21 p0184 A79-11483
- ALKYLATION**
  - Coal anion structure and chemistry of coal alkylation [COO-4227-2] 21 p0170 A79-10178
- ALPHA PARTICLES**
  - Compact experiments for alpha-particle heating --- of confined D-T plasma in tokamak 21 p0078 A79-14786
  - Alpha transport and blistering in tokamaks 22 p0253 A79-22243
  - Self-consistent analysis of alpha-particle heating of a fast-solenoid plasma --- in laser fusion 22 p0291 A79-27879
  - The effect of thermo-electric forces on the density profiles in a thermonuclear plasma surrounded by a cold blanket 22 p0292 A79-27886
- ALTERNATING CURRENT**
  - Proposals for power conditioning systems of high power communication satellites 21 p0033 A79-10897
- ALTERNATIVES**
  - Alternatives for coal based power generation - An international overview 21 p0008 A79-10074
  - Coal gasification and its alternatives 21 p0071 A79-14679
- ALUMINATES**
  - A study of positive electrode materials for batteries operating in a halide-aluminate medium 22 p0245 A79-21480
- ALUMINUM**
  - New processes for the recovery of resource materials from coal combustion wastes 21 p0007 A79-10065
  - Energy analysis of an aluminum solar collector 22 p0316 A79-31405
  - Method for making an aluminum or copper substrate panel for selective absorption of solar energy [NASA-CASE-NPS-23518-1] 21 p0182 A79-11469
- ALUMINUM ALLOYS**
  - The structure and properties of Cu based selective surfaces formed on an Al-Cu alloy by chemical brightening and etching treatments --- for flat plate solar collectors 21 p0127 A79-17384
  - Production and application of rolling-welded aluminum alloy panels for solar water heaters for hot water and cooling systems 22 p0297 A79-28670

## ALUMINUM GALLIUM ARSENIDES

- The design and evaluation of a 5 GW GaAlAs solar power satellite /SPS/ 21 p0002 A79-10024
- Performance of a tilted solar cell under various atmospheric conditions 21 p0066 A79-14261
- A high-efficiency GaAlAs double-heterostructure photovoltaic detector --- with antireflection coating 21 p0154 A79-18489
- A two-junction cascade solar-cell structure 22 p0256 A79-22856
- High-efficiency AlGaAs/GaAs concentrator solar cells 22 p0261 A79-23710
- Series resistance effects in /GaAl/As/GaAs concentrator solar cells 22 p0273 A79-25745
- Ga/1-x/Al/x/As-GaAs photovoltaic cells with multilayer structure --- heterostructure solar cell fabrication 22 p0305 A79-30258

## ALUMINUM OXIDES

- Preparation and ionic conductivity of H3O<sup>+</sup>/beta alumina --- for hydrogen-oxygen fuel cells 21 p0040 A79-11821
- Advanced batteries --- sodium sulfur batteries for electric motor vehicles 21 p0067 A79-14270
- Performance of molten salt sodium/beta-alumina/SbCl3 cells 22 p0245 A79-21479

## ALUMINUM SILICATES

- Ceramic applications in the advanced Stirling automotive engine 21 p0051 A79-12851

## AMBIPOlar DIFFUSION

- Response of a solar cell to intense and nonuniform illumination when used with solar concentrators 21 p0125 A79-17357

## AMMONIA

- Energy storage efficiency for the ammonia/hydrogen-nitrogen thermochemical energy transfer system 22 p0261 A79-23718

## AMORPHOUS SEMICONDUCTORS

- A new amorphous silicon-based alloy for electronic applications 21 p0100 A79-16226
- Amorphous semiconductors in photovoltaic and solar thermal conversion 21 p0122 A79-17339
- Characterisation of amorphous semiconductor materials for solar cell applications 21 p0123 A79-17341
- The interfacial layer in MIS amorphous silicon solar cells 22 p0258 A79-23039
- Chemical vapor deposited amorphous silicon for use in photothermal conversion 22 p0294 A79-28149
- Cast semicrystalline silicon for solar cells [ASME PAPER 79-SOL-16] 22 p0309 A79-30550

## ANAEROBES

- Use of solar energy to heat anaerobic digesters. Part 1: Technical and economic feasibility study. Part 2: Economic feasibility throughout the United States [PB-286940/2] 21 p0231 A79-15440
- The anaerobic attached film expanded bed reactor for the treatment of dilute organic wastes 22 p0356 A79-19928

## ANALOG CIRCUITS

- Temperature dependent parameter analysis of thermoelectric devices 21 p0113 A79-16740
- Validation of an electric circuit model of a solar house 22 p0321 A79-31440

## ANALOG SIMULATION

- A contribution to evaluation of flat-plate solar collectors performance 21 p0133 A79-17427
- Digital or analog modelling in the design of hydrostatic vehicular systems 22 p0264 A79-23808
- Solar-cell panel simulator 22 p0265 A79-23867

Validation of an electric circuit model of a solar house

Mathematical modelling of passive solar systems 22 p0321 A79-31440

## ANGLE OF ATTACK

Flying angle of attack 21 p0048 A79-12384

## ANGULAR DISTRIBUTION

Sun-position diagrams using examples from Flensburg to Mittenwald 21 p0055 A79-13626

## ANIMALS

A biologist's manual for the evaluation of impacts of coal-fired power plants on fish, wildlife and their habitats [PB-291330/9] 22 p0373 A79-21679

## ANIONS

Coal anion structure and chemistry of coal alkylation [COO-4227-2] 21 p0170 A79-10178

## ANNUAL VARIATIONS

Selection of method for calculating the parameters of wind and solar power station storage facilities 21 p0054 A79-13293

Hourly vs daily method of computing insolation on inclined surfaces 22 p0242 A79-21164

Prediction of the performance of solar heating systems utilizing annual storage 22 p0263 A79-23760

Solar radiation charts --- monthly average insolation 22 p0263 A79-23763

## ANODES

The anodic oxidation of ethyleneglycol at platinum, gold and Pt/Au-alloys in alkaline solution --- fuel cell electrocatalysis 21 p0037 A79-11795

Improved anodes for liquid hydrocarbon fuel cell [AD-A058456] 21 p0206 A79-13504

## ANTENNA ARRAYS

Large active retrodirective arrays for solar power satellites 21 p0107 A79-16604

Achievable flatness in a large microwave power antenna study [NASA-CR-151831] 21 p0171 A79-10272

Microwave systems analysis, solar power satellite --- alignment of the antenna array [NASA-CR-160091] 22 p0337 A79-16892

## ANTENNA DESIGN

Microwave phased array design considerations for SPS --- Solar Powered Satellites 21 p0003 A79-10031

Large active retrodirective arrays for solar power satellites 21 p0107 A79-16604

Attitude and pointing control system for the microwave antenna of the solar power satellite 21 p0113 A79-16739

Space will be the next big construction site 22 p0268 A79-24450

Superconductivity in antenna engineering 22 p0311 A79-31008

## ANTENNAS

Assessment of economic factors affecting the satellite power system. Volume 2: The systems implications of rectenna siting issues [NASA-CR-161186] 22 p0368 A79-21552

## ANTI-FRICTION BEARINGS

Plywheel components for satellite applications [AD-A060586] 21 p0226 A79-15145

## ANTIMONY

Sodium-antimony trichloride battery development program for load leveling [EPRI-EM-751] 21 p0186 A79-11501

Antimony, arsenic, and mercury in the combustible fraction of municipal solid waste [PB-285196/2] 21 p0213 A79-13590

## ANTIMONY COMPOUNDS

Performance of molten salt sodium/beta-alumina/SbCl3 cells 22 p0245 A79-21479

## ANTIREFLECTION COATINGS

Optimum antireflection coating for Antireflection-coated Metal-Oxide-Semiconductor /AMOS/ solar cells 21 p0042 A79-11955

- A high-efficiency GaAs double-heterostructure photovoltaic detector --- with antireflection coating  
21 p0154 A79-18489
- Silicon Schottky photovoltaic diodes for solar energy conversion  
[PB-287417/0] 22 p0343 N79-17349
- Optical coatings for solar cells and solar collectors. Citations from the NTIS data base  
[NTIS/PS-78/1341/3] 22 p0350 N79-18465
- Optical coatings for solar cells and solar collectors. Citations from the Engineering index data base  
[NTIS/PS-78/1342/1] 22 p0350 N79-18466
- APERTURES**  
An aperture-augmented prototype power satellite  
21 p0046 A79-12268
- APPROACH CONTROL**  
Procedure for flight guidance in the terminal maneuvering area for an experimental program employing a flying test device  
21 p0147 A79-17680
- APPROPRIATIONS**  
Authorizing appropriations to the National Aeronautics and Space Administration  
[H-REPT-96-52] 22 p0364 N79-20928
- APPROXIMATION**  
Isotropic distribution approximation in solar energy estimations --- diffuse insolation on tilted surface  
22 p0262 A79-23753
- AQUEOUS SOLUTIONS**  
Assessment of the potential of generating power from aqueous saline solutions by means of Osma-Hydro Power systems  
21 p0016 A79-10133
- Advanced electrolysis in alkaline solution --- for hydrogen production  
21 p0037 A79-11798
- AQUICULTURE**  
Multidisciplinary research related to the atmospheric sciences  
[PB-283076/8] 21 p0179 N79-10679
- Geothermal resources for aquaculture  
[PB-290345/8] 22 p0356 N79-19563
- AQUIFERS**  
Large-scale thermal energy storage for cogeneration and solar systems --- in aquifers  
21 p0092 A79-15886
- Underground aquifer storage of hot water from solar energy collectors  
21 p0120 A79-17317
- ARC DISCHARGES**  
Construction of a mathematical model for MHD generator electrodes in the arc regime of operation  
22 p0258 A79-23138
- ARC GENERATORS**  
Magnetic multipole line-cusp plasma generator for neutral beam injectors  
22 p0238 A79-20746
- ARC HEATING**  
Applications of thermal energy storage to process heat and waste heat recovery in the iron and steel industry  
[NASA-CR-159397] 21 p0183 N79-11473
- ARCHITECTURE**  
Vacation homes near the sea with solar and wind energy utilization - Research done at the Technical University of Hannover: Architectural considerations  
21 p0058 A79-13653
- Passive solar heating of buildings  
[LA-UR-77-1162] 21 p0090 A79-15859
- Long-term thermal storage in solar architecture in northern latitudes, with reference to typical single family dwellings  
21 p0119 A79-17313
- Analysis and design of solar buildings using the Cal-ERDA computer programs  
21 p0137 A79-17463
- Design of a low-energy house in Denmark heated by a combination of solar and wind energy  
21 p0138 A79-17471
- An earth-wrapped solar greenhouse house --- partially buried structure  
21 p0140 A79-17493
- Passive solar heating of buildings  
22 p0275 A79-25928
- Thomson Solar House I  
22 p0276 A79-25936
- CCMS solar energy pilot study reporting format - The zero energy house in Denmark  
22 p0277 A79-25940
- The Philips experimental house - A system's performance study --- of solar energy utilization and energy conservation  
22 p0277 A79-25941
- Passive solar energy design and materials --- Book  
22 p0302 A79-29625
- Component cost of solar energy systems  
22 p0319 A79-31429
- Energy management through energy conservation in buildings  
22 p0320 A79-31431
- Design study on solar energy systems for commercial buildings  
22 p0320 A79-31433
- Solar energy retrofit system for an older-type building - The Williamstown Museum project  
22 p0320 A79-31434
- ARCTIC REGIONS**  
An ocean thermal difference power plant in the Canadian Arctic  
22 p0318 A79-31415
- Power supplies for Arctic radio repeater systems  
[AD-A061609] 22 p0339 N79-17118
- AREA**  
Optimal sizing of solar collectors by the method of relative areas  
21 p0066 A79-14263
- ARGON**  
Changes in the terrestrial atmosphere-ionosphere-magnetosphere system due to ion propulsion for solar power satellite placement  
[NASA-TN-79719] 22 p0345 N79-17897
- ARGON PLASMA**  
A collisional plasma rotating between two cylinders  
21 p0049 A79-12694
- Performance of a closed-cycle MHD generator with molecular impurities  
22 p0283 A79-26524
- ARID LANDS**  
Small solar power plant with a Freon turbine  
21 p0057 A79-13642
- Possibilities for solar energy utilization in Egypt  
21 p0102 A79-16453
- Effect of dust on flat plate collectors  
21 p0129 A79-17399
- Solar energy, water, and industrial systems in arid lands: Technological overview and annotated bibliography  
[PB-285129/3] 21 p0211 N79-13549
- ARIZONA**  
Local perceptions of energy development: The case of the Kaiparowits Plateau  
[PB-297314/9] 22 p0335 N79-16380
- ARMED FORCES (UNITED STATES)**  
USAF terrestrial energy study. Volume 3, part 1: Summary data display  
[AD-A061071] 22 p0342 N79-17341
- Energy utilization survey pamphlet for buildings  
[AD-A062930] 22 p0371 N79-21624
- AROMATIC COMPOUNDS**  
Role of aromatics in soot formation  
21 p0053 A79-12988
- Methane formation during the hydrogasification and the gas phase pyrolysis of defined aromatics  
22 p0265 A79-23829
- ARTIFICIAL SATELLITES**  
Laser power conversion system analysis, volume 1  
[NASA-CR-159523-VOL-1] 22 p0366 N79-21334
- ASHES**  
Low-Btu gas from the IGT ash-agglomeration gasification process  
21 p0009 A79-10077
- The LASH /laser-ash/ particulate fragmentation removal concept for coal fired turbine power plants  
21 p0009 A79-10078
- Ash deposits and corrosion due to impurities in combustion gases; Proceedings of the International Conference, New England College, Henniker, N.H., June 26-July 1, 1977  
21 p0080 A79-14926

## ASPECT RATIO

- Modification of electrostatic precipitator performance by use of fly-ash conditioning agents [ASME PAPER 78-WA/APC-3] 21 p0158 A79-19736
- On the dynamics of electrostatically precipitated fly ash [ASME PAPER 78-WA/FU-3] 21 p0160 A79-19787
- Oxidation of SO<sub>2</sub> on the surface of fly ash particles under low relative humidity conditions 22 p0277 A79-26038
- A model for coal fly ash filtration 22 p0296 A79-28389
- Electrostatic precipitation tests with fuel oil ash 22 p0296 A79-28390
- Chemical studies of stack fly ash from a coal-fired power plant 22 p0309 A79-30595

## ASPECT RATIO

- Studies on the effect of bed aspect ratios and pressure drop on flow distribution in rock bed storage systems for solar energy applications 22 p0317 A79-31409

## ASSEMBLING

- Fabrication and assembly considerations for a base load MHD superconducting magnet system 22 p0235 A79-20534

## ASTIGMATISM

- Optical analysis of solar facility heliostats 22 p0296 A79-28360

## ASTRODYNAMICS

- Dynamics of stepping of the Hermes flexible solar array 22 p0323 A79-31615

## ASTRONOMICAL OBSERVATORIES

- Installation package for Hyde Memorial Observatory, Lincoln, Nebraska [NASA-CR-150867] 22 p0334 A79-16373

## ASYMMETRY

- The place of extreme asymmetrical non-focussing concentrators in solar energy utilization 21 p0149 A79-18024

## ASYMPTOTIC METHODS

- Asymptotic behaviour as a guide to the long term performance of solar water heating systems 21 p0041 A79-11872
- Asymptotic theory of dissipative trapped electron mode overlapping many rational surfaces --- in toroidal plasmas 22 p0270 A79-24855
- Two asymptotic solutions for analyzing the transverse edge effect in induction MHD machines 22 p0298 A79-29287

## ATLANTIC OCEAN

- A numerical model investigation of tidal phenomena in the Bay of Fundy and Gulf of Maine 22 p0323 A79-31554
- ERDA'S oceanographic program for the mid-Atlantic coastal region --- impact of offshore energy development on coastal ecology [BNL-24016] 21 p0192 A79-11641

## ATMOSPHERIC ATTENUATION

- Effects of weather and pollution on incident solar energy - Basic measurements leading to computer models 21 p0065 A79-14117
- Direct solar transmittance for a clear sky --- for insolation of solar conversion systems 22 p0296 A79-28361

## ATMOSPHERIC BOUNDARY LAYER

- Wind turbine generator wakes [AIAA PAPER 79-0113] 21 p0156 A79-19539
- Frequency distribution of wind speed near the surface 21 p0165 A79-20139

## ATMOSPHERIC CHEMISTRY

- Oxidation of SO<sub>2</sub> on the surface of fly ash particles under low relative humidity conditions 22 p0277 A79-26038
- Nitrogen oxide air pollution. Part 3: Atmospheric chemistry. A bibliography with abstracts [NTIS/PS-78/0973/4] 21 p0199 A79-12593

## ATMOSPHERIC COMPOSITION

- On the depletion of ambient ozone by a rural coal-fired power plant near Portage, Wisconsin 21 p0082 A79-15052
- The effects of different energy strategies on the atmospheric CO<sub>2</sub> concentration and climate 21 p0106 A79-16523

## SUBJECT INDEX

- The atmospheric CO<sub>2</sub> consequences of heavy dependence on coal 21 p0107 A79-16524
- The natural and perturbed troposphere 21 p0179 A79-10636
- ATMOSPHERIC EFFECTS**
- Climatic change in connection with energy growth --- resource consumption effects 22 p0284 A79-26623
- Changes in the terrestrial atmosphere-ionosphere-magnetosphere system due to ion propulsion for solar power satellite placement [NASA-TN-79719] 22 p0345 A79-17897
- ATMOSPHERIC ENERGY SOURCES**
- Thermal gradient-hydro generation cycle /TGUC/ 21 p0098 A79-16102
- ATMOSPHERIC MODELS**
- A probabilistic model of insolation for the Mojave desert-area 21 p0076 A79-14766
- The effects of different energy strategies on the atmospheric CO<sub>2</sub> concentration and climate 21 p0106 A79-16523
- Determining the terrestrial, incident solar flux on an arbitrarily oriented surface using available solar/weather data 21 p0119 A79-17310
- Stochastic simulation experiments on solar air conditioning systems 21 p0138 A79-17474
- ATMOSPHERIC OPTICS**
- Dependence of solar radiation availability on atmospheric turbidity 21 p0119 A79-17308
- ATMOSPHERIC PRESSURE**
- Flow modeling of an atmospheric pressure, entrained-type coal gasifier 22 p0280 A79-26188
- ATMOSPHERIC RADIATION**
- Determining the terrestrial, incident solar flux on an arbitrarily oriented surface using available solar/weather data 21 p0119 A79-17310
- ATMOSPHERIC SCATTERING**
- The circumsolar measurement program - Assessment of the effects of atmospheric scattering on solar energy conversion 21 p0082 A79-15077
- ATMOSPHERIC TEMPERATURE**
- Computation of IR sky temperature and comparison with surface temperature --- for solar collector energy budgets 21 p0042 A79-11875
- Power generation using thermal vapor pumping and hydro-pumped storage - Thermal gradient utilization cycle /TGUC/ 21 p0095 A79-15914
- Thermal gradient-hydro generation cycle /TGUC/ 21 p0098 A79-16102
- ATMOSPHERIC TURBULENCE**
- Analysis of wind turbine generator rotor response to one-dimensional turbulence 21 p0077 A79-14768
- ATOM CONCENTRATION**
- A simple neutral density profile calculation for tokamaks with lambda sub mp much smaller than a 22 p0255 A79-22379
- ATOMIC EXCITATIONS**
- Heat transport near the wall of a tokamak reactor 22 p0324 A79-31764
- ATOMIC STRUCTURE**
- Electronic structure and physical properties of Ti-H and Zr-H using NMR 22 p0248 A79-21685
- ATOMIZING**
- Ignition/stabilization/atomization - Alternative fuels in gas turbine combustors 21 p0052 A79-12982
- Combustion modification pollutant control techniques for industrial boilers - The influence of fuel oil properties and atomization parameters [ASME PAPER 78-WA/APC-13] 21 p0159 A79-19742
- ATTITUDE (INCLINATION)**
- Performance of a tilted solar cell under various atmospheric conditions 21 p0066 A79-14261



## SUBJECT INDEX

## AUTOMOBILE ENGINES

- Tilt, orientation and overshadowing of solar collectors in the Netherlands 21 p0131 A79-17414
- Optimum tilt for the flat plate collector 21 p0132 A79-17426
- AUGER SPECTROSCOPY**
- Study of the interaction of H<sub>2</sub>O and O<sub>2</sub> with the surface of TiO<sub>2</sub> by electron stimulated desorption and Auger and characteristic loss spectroscopies 21 p0037 A79-11793
- AUSTRIA**
- Austrian 10kW solar power plant. A project of the Federal Ministry for Science and Research 22 p0349 A79-18460
- AUTOCALVING**
- Catalytic hydrodesulfurization and liquefaction of coal - Batch autoclave studies 22 p0282 A79-26465
- AUTOMATIC CONTROL**
- Control of solar energy systems, heat storage, and heat utilization 21 p0056 A79-13630
- Field testing of 5-kW commercial wind generator with an automatic load-matching device for utilizing its output 21 p0143 A79-17515
- Computer based sun following system 22 p0242 A79-21165
- Stability of work and sensitivity of semiconductor thermoelectric systems under automatic control 22 p0261 A79-23624
- An approach to automated longwall mining [AIAA PAPER 79-0532] 22 p0274 A79-25871
- Automatic phase control in solar power satellite systems [NASA-CR-151856] 21 p0194 A79-12130
- Microprocessor control of a wind turbine generator [NASA-TM-79021] 21 p0195 A79-12548
- Phase 1 of the automated array assembly task of the low cost silicon solar array project [NASA-CR-158120] 22 p0348 A79-18451
- AUTOMATION**
- An approach to automated longwall mining [AIAA PAPER 79-0532] 22 p0274 A79-25871
- AUTOMOBILE ENGINES**
- Some problems and benefits from the hydrogen fueled spark ignition engine 21 p0016 A79-10130
- Combined cycle gas turbine for an automobile application 21 p0019 A79-10157
- Conceptual design of a variable displacement Stirling engine for automotive propulsion 21 p0025 A79-10207
- Mechanical efficiency of the Stirling cycle machine with rhombic drive 21 p0025 A79-10208
- The propulsion of vehicles by a flywheel 21 p0031 A79-10452
- Ceramic components for vehicular gas turbines 21 p0034 A79-11150
- Effect of inlet temperature on the performance of a catalytic reactor 21 p0035 A79-11542
- Automotive engines - A viable alternative for aircraft 21 p0047 A79-12379
- Designing and testing Si<sub>3</sub>N<sub>4</sub> turbine components at Mercedes-Benz 21 p0050 A79-12830
- Development of ceramic parts for a truck gas turbine at MTU 21 p0050 A79-12831
- Ceramics for the advanced automotive gas turbine engine - A look at a single shaft design 21 p0050 A79-12850
- Ceramic applications in the advanced Stirling automotive engine 21 p0051 A79-12851
- Correlations of catalytic combustor performance parameters 21 p0081 A79-14956
- The influence of lead compounds on automotive exhaust catalysts 21 p0116 A79-17253
- Real-time, continuous measurement of automotive sulfuric acid emissions 21 p0156 A79-19359
- Influences on exhaust emissions from automotive gas turbines [ASME PAPER 78-GT-85] 22 p0255 A79-22338
- Digital or analog modelling in the design of hydrostatic vehicular systems 22 p0264 A79-23808
- Optimization of a novel hydrostatic drive performance using hybrid computing technique --- for automobile engines 22 p0264 A79-23809
- Measured effects of flow leakage on the performance of the GT-225 automotive gas turbine engine [ASME PAPER 79-GT-3] 22 p0306 A79-30502
- A multivariable controller for an automotive gas turbine [ASME PAPER 79-GT-73] 22 p0307 A79-30537
- Efficiency studies about Daihatsu engine/electric hybrid system [SAE PAPER 790013] 22 p0314 A79-31352
- Air bearing development for a GM automotive gas turbine [SAE PAPER 790107] 22 p0314 A79-31355
- Poll type bearings for the Chrysler Automotive Gas Turbine Engine Program - Development and operational experiences [SAE PAPER 790109] 22 p0314 A79-31356
- Some design considerations of automotive gas turbines [SAE PAPER 790128] 22 p0314 A79-31360
- Field experience with the Detroit Diesel Allison 404/505 industrial gas turbine engines [SAE PAPER 790129] 22 p0314 A79-31361
- Initial comparison of single cylinder Stirling engine computer model predictions with test results [SAE PAPER 790327] 22 p0315 A79-31368
- An air/fuel control system for the Stirling engine [SAE PAPER 790328] 22 p0315 A79-31369
- The Stirling engine for automotive application [SAE PAPER 790329] 22 p0315 A79-31370
- A one-dimensional combustion model for a dual chamber stratified charge spark ignition engine [SAE PAPER 790355] 22 p0315 A79-31371
- Emissions and economy potential of prechamber stratified charge engines [SAE PAPER 790436] 22 p0315 A79-31374
- A new combustion system in the three-valve stratified charge engine [SAE PAPER 790439] 22 p0316 A79-31376
- US Army/Environmental Protection Agency re-refined engine oil program [AD-A056806] 21 p0171 A79-10216
- Variable-displacement spark-ignition engine [SAND-77-8299] 21 p0172 A79-10435
- Computer modeling of automotive engine combustion [UCRL-80451] 21 p0181 A79-11412
- Study of heat engine/flywheel: Hybrid propulsion configuration with electrical transmission system. Phase 2: Design definition [ALO-41/2] 21 p0185 A79-11493
- The Stirling engine for vehicle propulsion [NASA-TM-75442] 21 p0195 A79-12547
- The Otto-engine-equivalent vehicle concept [NASA-CR-157840] 21 p0203 A79-13370
- Investigation of turbo-dyne energy chamber (G:R: value trademark): An air bleed device [PB-285381/0] 21 p0217 A79-14397
- Air quality assessment of particulate emissions from diesel-powered vehicles [PB-286172/2] 21 p0223 A79-14641
- Performance characteristics of automotive engines in the United States. First Series: Report No. 14 1975 Mazda Rotary 79 CID (1.1 liters), 4V --- fuel consumption and emissions [PB-286074/0] 21 p0226 A79-15304
- Performance characteristics of automotive engines in the United States. First series: Report no. 15 1975 Dodge Colt 98 CID (1.6 liters), 2V [PB-286075/7] 21 p0226 A79-15305
- Performance characteristics of automotive engines in the United States. Second series: Report no. 5 1977 Ford 140 CID (2.3 liters), 2V --- fuel consumption and exhaust gases [PB-286076/5] 21 p0227 A79-15306

Performance characteristics of automotive engines in the United States Third series: Report No. 1 1977 Volvo 130 CID (2.1 liters), P.I. --- fuel consumption and exhaust gases [PB-286077/3] 21 p0227 N79-15307

Performance characteristics of automotive engines in the United States. Second series, report no. 4: 1976 Chevrolet 85 CID (1.4 liters), IV [PB-286294/4] 21 p0227 N79-15308

Performance characteristics of automotive engines in the United States. Second series, report no. 6: 1976 Nissan diesel 198 CID (3.2 liters), P. I. [PB-286295/1] 21 p0227 N79-15309

Performance characteristics of automotive engines in the United States. Second series, report no. 7: 1977 Ford 171 CID (2.8 liters), 2V [PB-286296/9] 21 p0227 N79-15310

Performance characteristics of automotive engines in the United States. First series, report no. 16: 1975 121 CID (2.0 liters), P.I. [PB-286297/7] 21 p0227 N79-15311

Performance characteristics of automotive engines in the United States. First series, report no. 17: 1975 Buick 455 CID (7.5 liters), 4V [PB-286298/5] 21 p0227 N79-15312

Performance characteristics of automotive engines in the United States. First series, report no. 18: 1976 Ford CID (6.6 liters), 2V --- fuel consumption and exhaust gases [PB-286299/3] 21 p0227 N79-15313

Performance characteristics of automotive engines in the United States. First series, report no. 20: 1975 Chevrolet 350 CID (5.7 liters) with dresser variable-area venturi system [PB-286301/7] 21 p0228 N79-15315

Update of development on the new Audi NSU rotary engine generation --- for application to aircraft engines 22 p0329 N79-15965

Cold-air performance of free power turbine designed for 112-kilowatt automotive gas-turbine engine. 2: Effects of variable stator-vane-chord setting angle on turbine performance [NASA-TM-78993] 22 p0345 N79-17859

Evaluation of ceramics for stator application: Gas turbine engine report [NASA-CR-159533] 22 p0364 N79-21075

**AUTOMOBILE FUELS**

The status of alcohol fuels utilization technology for highway transportation 21 p0003 A79-10035

Vehicle operation on fuels from solar energy 21 p0059 A79-13663

Federal automobile fuel economy standards - A status report 21 p0073 A79-14693

An air-modulated fluidic fuel-injection system --- automobile fuel management [ASME PAPER 78-WA/DSC-21] 21 p0159 A79-19766

Applications of metal hydrides --- emphasizing use as energy storage media 22 p0251 A79-21715

Denaturants for ethanol/gasoline blends [HCP/H2098-01] 21 p0180 N79-11237

Automotive Stirling engine development program [NASA-CR-159436] 21 p0181 N79-11406

Identification of probable automotive fuels consumption: 1985-2000, executive summary [HCP/H3684-01/2] 21 p0194 N79-12249

Status of alcohol fuels utilization technology for highway transportation [HCP/H2923-01] 21 p0201 N79-13190

Identification of probable automotive fuels composition: 1985-2000 [HCP/H3684-01/1] 21 p0201 N79-13191

The Otto-engine-equivalent vehicle concept [NASA-CR-157840] 21 p0203 N79-13370

**AUTOMOBILES**

Motor vehicle lead emissions in the United States - An analysis of important determinants, geographic patterns and future trends 21 p0113 A79-16745

Electric automobiles. Citations from the NTIS data base [NTIS/PS-78/0880/1] 21 p0171 N79-10363

Electric automobiles, volume 2. Citations from the engineering index data base [NTIS/PS-78/0881/9] 21 p0172 N79-10364

Effects of low ambient temperature on the exhaust emissions and fuel economy of 84 automobiles in Chicago [PB-288400/5] 22 p0355 N79-19488

**AUTOROTATION**

Lag damping in autorotation by a perturbation method --- for rigid rotor blades [AHS 78-25] 21 p0152 A79-18151

**AUXILIARY POWER SOURCES**

Partial energy supply to electric vehicles through solar cell system 21 p0077 A79-14767

The interface with solar - Alternative auxiliary supply systems --- for solar space heating 21 p0137 A79-17468

Design and development of a monorotor gas turbine auxiliary power unit [ASME PAPER 78-WA/GT-2] 21 p0160 A79-19791

Development of a high energy storage flywheel module [AD-A060351] 21 p0230 N79-15413

**AXES OF ROTATION**

Vertical axis wind turbine status 21 p0143 A79-17516

**AXIAL FLOW**

Performance prediction methods for horizontal axis wind turbines 21 p0045 A79-12244

**AXIAL FLOW TURBINES**

Low head power generation with bulb turbines --- hydroelectric installations 21 p0074 A79-14705

Operational characteristics of MHD turbine with air-core superconducting rotor 22 p0297 A79-28924

Cold-air performance of free power turbine designed for 112-kilowatt automotive gas-turbine engine. 2: Effects of variable stator-vane-chord setting angle on turbine performance [NASA-TM-78993] 22 p0345 N79-17859

**AXIAL LOADS**

Axial field limitations in MHD generators [FE-2341-8] 22 p0362 N79-20512

**AXISYMMETRIC BODIES**

Optimal geometries for one- and two-faced symmetric side-wall booster mirrors --- for solar collectors 21 p0149 A79-18019

**AZO COMPOUNDS**

Merocyanine organic solar cells 21 p0165 A79-20216

## B

**BACKSCATTERING**

Effects of nonlinear decay of backscattered light on the anomalous reflectivity --- in laser plasmas 22 p0310 A79-30742

**BACKUPS**

Distributed energy storage for solar applications 22 p0317 A79-31410

Off-peak electrical backup experience in the Meadowvale Solar Experiment 22 p0318 A79-31421

**BARIUM**

Optimization of a Knudsen Cs-Ba thermionic converter 22 p0241 A79-20940

**BARIUM OXIDES**

Energy storage using the reversible oxidation of barium oxide 22 p0242 A79-21169

**BAYS (TOPOGRAPHIC FEATURES)**

A numerical model investigation of tidal phenomena in the Bay of Fundy and Gulf of Maine 22 p0323 A79-31554

**BEAM SPLITTERS**

Multicolor solar cell power system for space 21 p0108 A79-16611

**BEAMS (RADIATION)**

Distribution of beam radiation of the receiver plane of a CPC solar concentrator --- Compound Parabolic Concentrators 21 p0135 A79-17451

**BEARINGS**

Development of a satellite flywheel family operating on one active axis magnetic bearings 22 p0366 N79-21392

**BEDS (GEOLOGY)**

- Underground gasification of coal at deep levels - Perspectives and problems 21 p0156 A79-19401
- Studies on the effect of bed aspect ratios and pressure drop on flow distribution in rock bed storage systems for solar energy applications 22 p0317 A79-31409

**BEDS (PROCESS ENGINEERING)**

- Feasible operating regions for moving bed coal gasification reactors 22 p0297 A79-28983
- The anaerobic attached film expanded bed reactor for the treatment of dilute organic wastes 22 p0356 A79-19928

**BENDING**

- Lag damping in autorotation by a perturbation method --- for rigid rotor blades [AHS 78-25] 21 p0152 A79-18151

**BENDING MOMENTS**

- Design of a D-shaped toroidal field coil 21 p0156 A79-19083

**BENEFICIATION**

- Beneficiation of lignites 21 p0146 A79-17642

**BETA PARTICLES**

- Fuel content characterization and pressure retention measurements of DT-filled laser fusion microballoon targets 22 p0258 A79-23034

**BIBLIOGRAPHIES**

- Bibliographic and numeric data bases for fiber composites and matrix materials 21 p0114 A79-16984
- Energy related mathematical models - Annotated bibliography 21 p0154 A79-18472
- Heat transfer - A review of 1977 literature 21 p0155 A79-18973
- Electric automobiles. Citations from the NTIS data base [NTIS/PS-78/0880/1] 21 p0171 A79-10363
- Electric automobiles, volume 2. Citations from the engineering index data base [NTIS/PS-78/0881/9] 21 p0172 A79-10364
- Energy conservation: Policies, programs and general studies. A bibliography with abstracts [NTIS/PS-78/0693/8] 21 p0176 A79-10552
- Solar ponds. Citations from the NTIS data base [NTIS/PS-78/0836/3] 21 p0176 A79-10553
- Solar ponds. Citations from the engineering index data base [NTIS/PS-78/0837/1] 21 p0176 A79-10554
- Solar energy concentrator design and operation. Citations from the NTIS data base [NTIS/PS-78/0838/9] 21 p0178 A79-10566
- Technology assessment, volume 2. A bibliography with abstracts [NTIS/PS-78/0830/6] 21 p0179 A79-10951
- Electric batteries. A bibliography [TID-3361] 21 p0184 A79-11491
- Design and applications of flywheels. Citations from the NTIS data base [NTIS/PS-78/0997/3] 21 p0190 A79-11550
- Design and applications of flywheels. Citations from the engineering index data base [NTIS/PS-78/0998/1] 21 p0190 A79-11551
- Energy policy and research planning, volume 2. A bibliography with abstracts [NTIS/PS-78/0961/9] 21 p0191 A79-11552
- Energy policy and research planning, volume 3. A bibliography with abstracts [NTIS/PS-78/0962/7] 21 p0191 A79-11553
- Nitrogen oxide air pollution. Volume 2, part 1: Control technology. A bibliography with abstracts [NTIS/PS-78/0971/8] 21 p0199 A79-12591
- Nitrogen oxide air pollution. Part 3: Atmospheric chemistry. A bibliography with abstracts [NTIS/PS-78/0973/4] 21 p0199 A79-12593
- Solar space heating and air conditioning, volume 2. Citations from the NTIS data base [NTIS/PS-78/1014/6] 21 p0211 A79-13545
- Solar space heating and air conditioning volume 3. Citations from the NTIS data base [NTIS/PS-78/1015/3] 21 p0211 A79-13546
- Solar space heating and air conditioning, volume 3. Citations from the engineering index data base [NTIS/PS-78/1017/9] 21 p0211 A79-13547

Solar energy, water, and industrial systems in arid lands: Technological overview and annotated bibliography

- [PB-285129/3] 21 p0211 A79-13549
- Solar space heating and air conditioning, volume 2. Citations from the engineering index data base [NTIS/PS-78/1016/1] 21 p0212 A79-13550
- Flat plate solar collector design and performance. Citations from the NTIS data base [NTIS/PS-78/0840/5] 21 p0212 A79-13551
- An annotated compilation of the sources of information related to the usage of electricity in non-industrial applications [PB-285260/6] 21 p0212 A79-13552
- Silicon solar cells, volume 2. Citations from the NTIS data base [NTIS/PS-78/1114/4] 21 p0212 A79-13554
- Silicon solar cells, volume 3. Citations from the NTIS data base [NTIS/PS-78/1115/1] 21 p0212 A79-13555
- Silicon solar cells, volume 2. Citations from the NTIS data base [NTIS/PS-78/1116/9] 21 p0212 A79-13556
- Solar electric power generation, volume 2. Citations from the NTIS data base [NTIS/PS-78/1108/6] 21 p0212 A79-13557
- Solar electric power generation, volume 2. Citations from the Engineering Index data base [NTIS/PS-78/1109/4] 21 p0212 A79-13558
- FY 1978 scientific and technical reports, articles, papers, and presentations --- bibliography [NASA-TM-78203] 21 p0214 A79-13915
- Combined cycle power generation. Citations from the NTIS data base [NTIS/PS-78/1156/5] 21 p0222 A79-14587
- Combined cycle power generation. Citations from the Engineering Index data base [NTIS/PS-78/1157/3] 21 p0222 A79-14588
- Cadmium sulfide solar cells. Citations from the NTIS data base [NTIS/PS-78/1213/4] 21 p0231 A79-15436
- Cadmium sulfide solar cells. Citations from the Engineering Index data base [NTIS/PS-78/1214/2] 21 p0231 A79-15437
- Cryogenic refrigeration, volume 2. A bibliography with abstracts [NTIS/PS-78/1261/3] 22 p0331 A79-16144
- Cryogenic refrigeration, volume 3. A bibliography with abstracts [NTIS/PS-78/1262/1] 22 p0331 A79-16145
- Oil pollution reports, volume 5, number 2 --- bibliographies [PB-287071/5] 22 p0336 A79-16437
- Solar water pumps. Citations from the Engineering Index data base [NTIS/PS-78/1288/6] 22 p0343 A79-17348
- Optical coatings for solar cells and solar collectors. Citations from the NTIS data base [NTIS/PS-78/1341/3] 22 p0350 A79-18465
- Optical coatings for solar cells and solar collectors. Citations from the Engineering index data base [NTIS/PS-78/1342/1] 22 p0350 A79-18466
- Synthetic fuels: Methane. Citations from the Engineering Index data base [NTIS/PS-79/0030/1] 22 p0365 A79-21223

**BINARY FLUIDS**

- Liquid mixture excess volumes and total vapor pressures using a magnetic suspension densimeter with compositions determined by chromatographic analysis Methane plus ethane 21 p0085 A79-15324

**BIOASSAY**

- Status of bioscreening of emissions and effluents from energy technologies 22 p0346 A79-18353

**BIOCHEMICAL FUEL CELLS**

- Utility fuel cells for biomass fuel 21 p0016 A79-10131

**BIODEGRADATION**

- Stimulated biodegradation of waste petroleum 22 p0336 A79-16388

**BIOGEOCHEMISTRY**

- Organic geochemical studies on kerogen precursors in recently deposited algal mats and oozes 21 p0031 A79-10419

# BIOLOGICAL EFFECTS

# SUBJECT INDEX

## BIOLOGICAL EFFECTS

Some perspectives on research into the biological response to non-ionizing electromagnetic radiation --- relation to SETI, SPS, and other government projects

22 p0271 A79-24879

Energy-related pollutants in the environment: The use of short-term for mutagenicity in the isolation and identification of biohazards [CONF-780121-2]

21 p0192 A79-11568

Marine biological effects of OCS petroleum development

[PB-288935/0]

22 p0344 A79-17374

Health effects associated with diesel exhaust emissions, literature review and evaluation [PB-289817/9]

22 p0364 A79-20727

## BIOELECTRICITY

Calculation of the external electromagnetic field of closely spaced MHD machines

22 p0298 A79-29285

## BIOMASS

Solid waste and biomass. Their potential as energy sources in Illinois, 1977

[PB-281649/4]

21 p0177 A79-10562

## BIOMASS ENERGY PRODUCTION

Energy from biomass through hydrolysis of wood

21 p0003 A79-10036

The Garrett Energy Research biomass gasification process

21 p0004 A79-10037

Utility fuel cells for biomass fuel

21 p0016 A79-10131

Compartmental model for agricultural conversion of solar energy into fixed biomass

21 p0022 A79-10181

There is a lot of energy in digester gas . . . use it --- in municipal waste water plants

21 p0035 A79-11448

Liquid fuels from biomass

21 p0063 A79-13676

Biomass and wastes as energy resources - 1977 update

21 p0091 A79-15868

Petroleum plantations --- hydrocarbon fuels from artificial photosynthesis and plants

21 p0095 A79-15910

New concepts in waste utilization and biomass

21 p0095 A79-15915

Advanced processes for more efficient use of forest products residual material

21 p0096 A79-15919

Inexpensive solar energy utilization in human settlements

21 p0104 A79-16470

Urban wastes as an energy source

21 p0115 A79-17220

Energy through solar aided bio-gas systems

21 p0125 A79-17367

Efficiency of sugar cane and cowpea as solar energy converters

21 p0125 A79-17368

Harvesting solar energy using biological systems

21 p0126 A79-17372

Bio-mass energy for rural areas

21 p0126 A79-17373

Electrochemical use of biomass

22 p0254 A79-22273

Biological conversion of solar energy

22 p0312 A79-31146

Conversion of biomass materials into gaseous products, phase 1

[SAH/1241-77/1]

21 p0171 A79-10237

Biomass utilization in Minnesota

[PB-282531/3]

21 p0171 A79-10241

Parameters for legislative consideration of bioconversion technologies

[PB-284742/4]

21 p0194 A79-12250

Biological solar energy conversion approaches to overcome yield stability and product limitations

[PB-284823/2]

21 p0199 A79-12577

The economics and engineering of large-scale algae biomass energy systems

[PB-287868/4]

21 p0226 A79-15207

Identification of wood energy resources in central Michigan

[NASA-CR-158130]

22 p0347 A79-18924

Bioconversion study conducted by JPL

[NASA-CR-158228]

22 p0354 A79-19450

Preliminary environmental assessment of biomass conversion to synthetic fuels

[PB-289775/9]

22 p0365 A79-21224

## BIOSPHERE

Protection of the biosphere --- MHD power stations pollution reduction

21 p0105 A79-16483

## BITUMENS

Continuous extrusion of coal --- plastic fluidizing process

22 p0282 A79-26372

Factors affecting bitumen recovery by the hot water process

22 p0282 A79-26463

A mass and energy balance of a Wellman-Galusha gasifier --- bituminous coal conversion

22 p0283 A79-26467

Bituminous coal extraction in terms of electron-donor and -acceptor interactions in the solvent/coal system

22 p0283 A79-26469

Technology and Use of Lignite --- conferences

[GPERC/IC-77/1]

21 p0216 A79-14241

## BLACK BODY RADIATION

A new concept for solar pumped lasers

21 p0110 A79-16624

Thermodynamics of the conversion of diluted radiation --- solar energy application

22 p0310 A79-30910

Blackbody optical pumping of carbon dioxide laser mixtures

21 p0203 A79-13343

## BLANKETS (FUSION REACTORS)

Nuclear characteristics of D-D fusion reactor blankets - Technical data

21 p0162 A79-19826

The potential of fusion reactors as process heat source

22 p0284 A79-26624

The effect of thermo-electric forces on the density profiles in a thermonuclear plasma surrounded by a cold blanket

22 p0292 A79-27886

Thermoelectric magnetohydrodynamics

22 p0312 A79-31098

## BODY CENTERED CUBIC LATTICES

Advanced batteries --- sodium sulfur batteries for electric motor vehicles

21 p0067 A79-14270

## BOILERS

Circulating-bed boiler concepts for steam and power generation

21 p0008 A79-10071

Use of alternative fuels in stationary combustors

21 p0052 A79-12981

Particulate control for coal-fired industrial boilers

21 p0065 A79-14123

Solid waste and coal firing in industrial boilers

21 p0096 A79-15918

Steam generator and turbomachines --- MHD power plant design and Soviet operational experience

21 p0106 A79-16489

Reducing inefficiency and emissions of large steam generators in the United States

21 p0114 A79-17075

Honeycomb type flat plate collectors - Experiments leading to drinking straw --- heat retention material for solar steam generation

21 p0132 A79-17424

A survey of particulate collection devices for coal-fired boilers

21 p0147 A79-17645

Operation and emission of a stoker-fired boiler while burning refuse derived fuel and coal mixtures

21 p0158 A79-19735

Combustion modifications for the control of air pollutant emissions from coal fired utility boilers

21 p0158 A79-19738

Combustion modification pollutant control techniques for industrial boilers - The influence of fuel oil properties and atomization parameters

21 p0159 A79-19742

[ASHE PAPER 78-WA/APC-13]

## SUBJECT INDEX

## BUILDINGS

- Corrosion and deposits from combustion of solid waste. VI - Processed refuse as a supplementary fuel in a stoker-fired boiler [ASME PAPER 78-WA/PU-4] 21 p0160 A79-19788
- Solar storage unit with built-in oil-gas boiler 22 p0268 A79-24322
- Performance of a 5 Mwt solar steam generator 22 p0288 A79-27399
- Ways of improving steam-gas power plants --- fuel economy 22 p0299 A79-29298
- Soot and the combined cycle boiler [ASME PAPER 79-GT-67] 22 p0307 A79-30533
- Particulate and sulfur dioxide emission control costs for large coal-fired boilers [PB-281271/7] 21 p0178 A79-10591
- Brookhaven National Laboratory burner-boiler/furnace efficiency test project. Annual fuel use and efficiency reference manual: hydronic equipment [BNL-50816] 21 p0210 A79-13538
- Proceedings of Symposium on water-in-fuel emulsions in combustion --- marine diesels, boilers, and gas turbine engines [AD-A061503] 22 p0338 A79-17019
- Low-sulfur western coal use in existing small and intermediate size boilers --- particulate sampling and combustion efficiency [PB-287937/7] 22 p0346 A79-18061
- Engineering test facility conceptual design, part 2 [PE-2614-2-PT-2] 22 p0369 A79-21561
- BOMBER AIRCRAFT**
- An analysis of fuel conserving operational procedures and design modifications for bomber/transport aircraft. Volume 1: Executive summary [AD-A061746] 22 p0351 A79-18969
- An analysis of fuel conserving operational procedures and design modifications for bomber/transport aircraft, volume 2 [AD-A062609] 22 p0356 A79-20109
- BORING MACHINES**
- Borehole geological assessment [NASA-CASE-WFO-14231-1] 22 p0356 A79-19521
- BOUNDARY LAYER CONTROL**
- Drag reduction by cooling in hydrogen fueled aircraft 21 p0165 A79-20084
- BOUNDARY LAYER FLOW**
- Attenuating the transverse edge effect in MHD generators 21 p0063 A79-13985
- Wind turbine generator wakes [AIAA PAPER 79-0113] 21 p0156 A79-19539
- BOUNDARY LAYER PLASMAS**
- Effect of finite boundary layer on the ionization instability in non-equilibrium MHD generators 21 p0153 A79-18469
- MHD stability of Spheromak. 22 p0313 A79-31189
- The formulation of the wall stabilization problem of an axisymmetrical toroidal sharp-boundary plasma with a horizontally elongated noncircular cross section 22 p0327 A79-32103
- BOUNDARY LAYER SEPARATION**
- Demonstration of a rotary separator for two-phase brine and steam flows [TID-28519] 22 p0365 A79-21309
- BOUNDARY LAYERS**
- Transport phenomena in MHD generators - Effect of boundary layers 21 p0156 A79-19098
- BRAKES (FOR ARRESTING MOTION)**
- The brake system for the DOE/Sandia 17-meter vertical axis wind turbine 21 p0067 A79-14289
- Optimal control of on-board and station flywheel storage for rail transit systems 21 p0148 A79-17822
- Wayside energy storage summary. Volume 1: Summary [DOT-TSC-FRA-79-7-1-VOL-1] 22 p0370 A79-21563
- BRAKING**
- Optimal control of on-board and station flywheel storage for rail transit systems [ASME PAPER 78-WA/DSC-32] 21 p0159 A79-19771
- BRAYTON CYCLE**
- Combined cycle gas turbine for an automobile application 21 p0019 A79-10157
- Brayton Isotope Power System - The versatile dynamic power converter --- for spacecraft 21 p0023 A79-10190
- Influence of cyclic wall-to-gas heat transfer in the cylinder of the valved hot-gas engine 21 p0024 A79-10201
- A ceramic heat exchanger for a Brayton cycle solar electric power plant 22 p0239 A79-20822
- Thermodynamic basis for combining cycles of heat producing power plants 22 p0298 A79-29297
- Mini-BRU/BIPS 1300 watt (sub)dynamic power conversion system development: Executive summary [NASA-CR-159440] 21 p0173 A79-10526
- Mini-Brayton heat source assembly development [NASA-CR-159447] 21 p0196 A79-12554
- Benefits of solar/fossil hybrid gas turbine systems [NASA-TN-79083] 21 p0229 A79-15410
- BRAZIL**
- Heat flow and radiogenic heat production in Brazil with implications for thermal evolution of continents 22 p0373 A79-21689
- BREADBOARD MODELS**
- A parabolic solar reflector for accurate and economic producibility 22 p0293 A79-28145
- BREAKDOWN**
- 'Local' breakdown criterion in highly ionized gas flow 21 p0049 A79-12683
- BREMSSTRAHLUNG**
- Compact experiments for alpha-particle heating --- of confined D-T plasma in tokamak 21 p0078 A79-14786
- BRILLOUIN EFFECT**
- Self-adjusting laser-target system for laser fusion 21 p0086 A79-15625
- BRINES**
- Demonstration of a rotary separator for two-phase brine and steam flows [TID-28519] 22 p0365 A79-21309
- An assessment of subsurface salt water disposability experience on the Texas and Louisiana Gulf Coast for application to disposal of salt water from geopressured geothermal wells [WVO/1531-2] 22 p0366 A79-21523
- BROMIDES**
- Performance predictions of a LiBr absorption air conditioner utilizing solar energy 21 p0139 A79-17482
- Integration of evacuated tubular solar collectors with lithium bromide absorption cooling systems 21 p0139 A79-17483
- Solar energy storage as hydrogen and bromine from hydrogen bromide 22 p0265 A79-24045
- BROMINE**
- The thermochemical decomposition of water using bromine and iodine 22 p0238 A79-20770
- Supply of reactants for Redox bulk energy storage systems [NASA-TN-78995] 21 p0183 A79-11479
- BROMINE COMPOUNDS**
- The production of solar cell grade silicon from bromosilanes [NASA-CR-158362] 22 p0358 A79-20482
- BUDGETING**
- Guide to reducing energy-use budget costs [BCE/U60505-01] 21 p0184 A79-11489
- Economic impacts of a transition to higher oil prices --- estimation and budget allocations [BNL-50871] 22 p0364 A79-20927
- BUILDINGS**
- The application of photovoltaic roof shingles to residential and commercial buildings 21 p0020 A79-10170
- Predicting the performance of passive solar-heated buildings 21 p0063 A79-13899
- Economic optimization of heatpump assisted solar heating in Illinois 21 p0072 A79-14691

Fuel cell on-site integrated energy system  
parametric analysis of a residential complex  
21 p0081 A79-14947

Principles of solar cooling and heating  
21 p0103 A79-16457

Integrated solar building systems  
21 p0103 A79-16460

Energy utilization analysis of buildings  
21 p0103 A79-16462

Annual collection and storage of solar energy for  
the heating of buildings  
21 p0131 A79-17415

Design of solar heating system for winter heating  
of buildings /A case study/  
21 p0139 A79-17486

Pressure measurements on wind tunnel models of the  
Aylesbury experimental house  
22 p0300 A79-29372

Energy management through energy conservation in  
buildings  
22 p0320 A79-31431

Design study on solar energy systems for  
commercial buildings  
22 p0320 A79-31433

Solar energy retrofit system for an older-type  
building - The Williamstown Museum project  
22 p0320 A79-31434

Instrumentation at the Decade 80 solar house in  
Tucson, Arizona  
[NASA-CR-150851]  
21 p0204 A79-13491

Verification methodology for the DOE-1 building  
energy analysis computer program  
[LA-UR-78-1493]  
21 p0208 A79-13520

Comparison of fuel-cell and diesel integrated  
energy systems and a conventional system for a  
500-unit apartment  
[NASA-TM-79037]  
21 p0229 A79-15403

Phase one/base data for the development of energy  
performance standards for new buildings: Data  
analysis  
[PB-286901/4]  
22 p0331 A79-16148

Phase one/base data for the development of energy  
performance standards for new buildings: Sample  
design  
[PB-286903/0]  
22 p0331 A79-16150

The effects of resource impact factors on energy  
conservation standards for buildings  
[PB-286909/7]  
22 p0335 A79-16384

Phase one/base data for the development of energy  
performance standards for new buildings.  
Climatic classification  
[PB-286900/6]  
22 p0336 A79-16497

Life-cycle costing. A guide for selecting energy  
conservation projects for public buildings ---  
computing the cost effectiveness of retrofitting  
and new buildings  
[PB-287804/9]  
22 p0345 A79-17744

Buildings energy use data book, edition 1  
[ORNL-5363]  
22 p0348 A79-18447

The updated algorithm of the Energy Consumption  
Program (ECP): A computer model simulating  
heating and cooling energy loads in buildings  
22 p0351 A79-19059

Solar heating of buildings: Design optimization  
and economic analysis  
22 p0353 A79-19439

Phase one/base data for the development of energy  
performance standard for new buildings. Task  
report: Building classification  
[PB-286904/8]  
22 p0355 A79-19468

Solar building regulatory study, volume 2  
[PB-289824/5]  
22 p0357 A79-20291

Solar energy pilot study  
[PB-289380/8]  
22 p0363 A79-20525

Solar space heaters for low-income families  
[PB-289244/6]  
22 p0363 A79-20526

Solar building regulatory study, volume 1  
[PB-289823/7]  
22 p0365 A79-21235

Energy utilization survey pamphlet for buildings  
[AD-A062930]  
22 p0371 A79-21624

Conservation where it counts: Energy management  
systems  
[PB-289837/7]  
22 p0372 A79-21628

Interim performance criteria for solar heating and  
cooling systems in residential buildings, second  
edition  
[PB-289967/2]  
22 p0372 A79-21630

BUOYANCY  
Effect of buoyancy and tube inclination on heat  
transfer in a solar air heater  
21 p0129 A79-17402

Buoyancy effects in a solar regenerator --- for  
air dehumidifier absorbent solutions  
22 p0262 A79-23752

BUOYS  
Wave power electric generation study in Japan ---  
large scale buoy facility  
21 p0151 A79-18107

BURNERS  
Regenerative burner system for thermoelectric  
power sources  
22 p0261 A79-23621

Brookhaven National Laboratory  
burner-boiler/furnace efficiency test project.  
Annual fuel use and efficiency reference manual:  
hydraulic equipment  
[BNL-50816]  
21 p0210 A79-13538

BURNING RATE  
LAG-Process, some results of utilization in  
transport and mechanical engineering  
21 p0030 A79-10248

Combustion rates for oil shale carbonaceous residue  
21 p0032 A79-10522

Combustion of droplets and sprays of some  
alternative fuels  
21 p0052 A79-12983

BY-PRODUCTS  
Chemical production from waste carbon monoxide:  
Its potential for energy conservation  
[BNWL-2137]  
21 p0170 A79-10179

BYPASSES  
Analysis of electrolyte shunt currents in fuel  
cell powerplants  
21 p0039 A79-11816

C

C-135 AIRCRAFT  
Winglets give USAF KC-135 new look in life  
22 p0265 A79-23975

CADMIUM COMPOUNDS  
Photovoltaic effects in II-VI heterojunctions  
21 p0042 A79-11967

CADMIUM SELENIDES  
Polycrystalline CdSe-based photo-electrochemical  
cells  
21 p0037 A79-11785

CADMIUM SULFIDES  
n-CdS/p-GaAs photoanode --- electrochemical solar  
cells  
21 p0037 A79-11784

Recent progress in thin film polycrystalline solar  
cells based on cadmium sulfide  
21 p0042 A79-11966

Cu<sub>2</sub>S-CdS thin-film solar cells  
21 p0057 A79-13637

The photovoltaic effect in CdS/Cu<sub>2</sub>S solar cells  
21 p0091 A79-15871

Investigation on junction formation and  
realisation of high open-circuit voltage in  
Cu<sub>x</sub>/S-CdS solar cells  
21 p0123 A79-17348

Improvement of efficiency and stability by  
copper-treatment and front contacting of  
Cu<sub>x</sub>/S-CdS solar cells  
21 p0123 A79-17345

Sprayed CdS thin films for CdS/Cu<sub>2</sub>S heterojunction  
solar cells  
21 p0123 A79-17346

The photovoltaic effects in CdS/Cu<sub>2</sub>S solar cells  
21 p0123 A79-17347

Role of the diode exponential factor in CdS solar  
cells  
21 p0123 A79-17348

A pilot line for the production of large area  
Cu<sub>x</sub>/S-CdS solar cells  
21 p0124 A79-17351

A diagnostic study on the polycrystalline nature  
and its relationship with the yield of CdS solar  
cell  
21 p0125 A79-17361

Photoelectric properties of pCdTe-nCdS film  
heterojunctions  
21 p0166 A79-20347

# SUBJECT INDEX

# CARBON MONOXIDE

- Calculating the photocurrent and maximum efficiency of film p-CdTe-n-CdS photocells 21 p0166 A79-20354
- The design and fabrication of CdS/Cu<sub>2</sub>S cells of 8.5-percent conversion efficiency 22 p0300 A79-29428
- Low cost thin-film CdS-based solar cells progress and promise [ASME PAPER 79-SOL-15] 22 p0309 A79-30549
- Cadmium sulfide solar cells. Citations from the NTIS data base [NTIS/PS-78/1213/4] 21 p0231 A79-15436
- Cadmium sulfide solar cells. Citations from the Engineering Index Data base [NTIS/PS-78/1214/2] 21 p0231 A79-15437
- CADMIUM TELLURIDES**
- Photoelectric properties of pCdTe-nCdS film heterojunctions 21 p0166 A79-20347
- Calculating the photocurrent and maximum efficiency of film p-CdTe-n-CdS photocells 21 p0166 A79-20354
- CAISSONS**
- Prefabricated caissons for tidal power development 21 p0152 A79-18113
- CALCIUM OXIDES**
- Stabilization of power plant scrubbing slurries and fine coal refuse with the additive Calcilox 21 p0063 A79-14107
- A regenerative process for fluidized-bed combustion of coal with lime additives 22 p0297 A79-28984
- CALCIUM SULFIDES**
- Calcium/iron sulfide secondary cells 21 p0041 A79-11835
- CALIBRATING**
- Calibration standards and field instruments for the precision measurement of insolation 21 p0076 A79-14765
- Flow rate calibration for solar heating and cooling system evaluation 21 p0089 A79-15845
- Temperature calibration for solar heating and cooling system evaluation 21 p0089 A79-15846
- CALIFORNIA**
- Santa Clara Community Center Project, USA --- solar building --- 22 p0277 A79-25945
- Direct heat applications of geothermal energy in the geysers/Clear Lake Region, volume 2: Environmental assessment [SAN/1326-1/2] 21 p0174 A79-10532
- Recommendations for the conceptual design of the Barstow, California, solar central receiver pilot plant: Executive summary [SAND-77-8035] 21 p0221 A79-14571
- Cooking with offshore oil: A handbook for California local government --- regional planning [PB-288656/2] 22 p0331 A79-16140
- Geothermal element, Imperial County, California [PB-287115/0] 22 p0335 A79-16385
- CALORIMETERS**
- The measurement of optical properties of selective surfaces using a solar calorimeter 21 p0041 A79-11874
- Photoacoustic determination of photovoltaic energy conversion efficiency 21 p0154 A79-18503
- 1kW calorimetric receiver for Solar Thermal Test Facility [ASME PAPER 78-WA/SOL-7] 21 p0163 A79-19839
- CARBON**
- The influence of blade camber on the output of vertical-axis wind turbines 21 p0045 A79-12242
- CANADA**
- Mississauga solar house /Mississauga, Ontario, Canada/ 22 p0276 A79-25935
- The role of applied meteorology in the Canadian energy programme 22 p0317 A79-31414
- An ocean thermal difference power plant in the Canadian Arctic 22 p0318 A79-31415
- ERC solar monitoring program 22 p0318 A79-31419
- The Prince Edward Island Wind Energy Program 22 p0319 A79-31427
- Coal preparation design for export markets, with particular reference to South African and Canadian coals 22 p0340 A79-17318
- CAPACITANCE SWITCHES**
- Problems in the development of high-service-life capacitive accumulators --- for fusion reactors 22 p0243 A79-21249
- CAPACITORS**
- Induction-generator/synchronous-condenser system for wind-turbine power 22 p0286 A79-27219
- CARBIDES**
- DC reactively sputtered metal carbide and metal silicide selective absorbing surfaces --- for photothermal solar energy conversion 21 p0126 A79-17377
- CARBON**
- Combustion rates for oil shale carbonaceous residue 21 p0032 A79-10522
- Catalytic effect of Ni and K<sub>2</sub>CO<sub>3</sub> in the gasification of carbon and coal 22 p0364 A79-21215
- CARBON COMPOUNDS**
- Kinetic modeling of pyrolysis and hydrogasification of carbonaceous materials --- converting wood waste char to clean fuels 21 p0179 A79-11150
- Surfactant-assisted liquefaction of particulate carbonaceous substances [NASA-CASE-WPO-13904-1] 21 p0179 A79-11152
- CARBON DIOXIDE**
- The effects of different energy strategies on the atmospheric CO<sub>2</sub> concentration and climate 21 p0106 A79-16523
- The atmospheric CO<sub>2</sub> consequences of heavy dependence on coal 21 p0107 A79-16524
- A comparison of the performance of steam turbine cycles using gas contaminated geothermal steam [ASME PAPER 78-WA/ENER-3] 21 p0159 A79-19776
- Methane production from carbon oxides over borohydride-reduced transition metals [PB-286385/0] 21 p0226 A79-15177
- CARBON DIOXIDE CONCENTRATION**
- Molten-carbonate CO<sub>2</sub> concentrator - Preliminary experiments [ASME PAPER 78-ENAS-2] 21 p0048 A79-12551
- CARBON DIOXIDE LASERS**
- CO<sub>2</sub>-laser fusion 21 p0018 A79-10150
- DOE programs in material development for fusion laser systems 21 p0082 A79-15137
- The TELEC - A plasma type of direct energy converter --- Thermo-Electronic Laser Energy Converter for electric power generation 21 p0110 A79-16629
- Prepulse damage to targets and alignment verification 22 p0258 A79-23027
- Blackbody optical pumping of carbon dioxide laser mixtures 21 p0203 A79-13343
- CARBON DIOXIDE REMOVAL**
- Molten-carbonate CO<sub>2</sub> concentrator - Preliminary experiments [ASME PAPER 78-ENAS-2] 21 p0048 A79-12551
- Wilson parameters for the system H<sub>2</sub>, N<sub>2</sub>, CO, CO<sub>2</sub>, CH<sub>4</sub>, H<sub>2</sub>S, CH<sub>3</sub>OH, and H<sub>2</sub>O --- for cold methanol absorption in coal gasification 22 p0282 A79-26462
- CARBON FIBER REINFORCED PLASTICS**
- Rotating strength of glass-carbon fiber-reinforced hybrid composite discs 21 p0165 A79-20273
- CARBON MONOXIDE**
- Evaluation of commercial catalysts for the Fischer-Tropsch reaction --- for coal conversion to liquid fuel or chemical feedstock 22 p0272 A79-25124
- The economics of hydrogen and carbon monoxide separation with cuprous ammonium lactate solutions --- hydrogen production from coal 22 p0299 A79-29313

# CARBON MONOXIDE LASERS

# SUBJECT INDEX

Chemical production from waste carbon monoxide:  
 Its potential for energy conservation  
 [BNWL-2137] 21 p0170 A79-10179

Methane production from carbon oxides over  
 borohydride-reduced transition metals  
 [PB-286385/0] 21 p0226 A79-15177

**CARBON MONOXIDE LASERS**

Laser aircraft --- using kerosene  
 22 p0284 A79-26597

**CARBONATES**

An improved method for analysis of hydroxide and  
 carbonate in alkaline electrolytes containing zinc  
 21 p0035 A79-11546

Molten carbonate fuel cell systems - Status and  
 potential  
 21 p0039 A79-11817

Partial processes and transport parameters in  
 molten carbonate fuel cell operation  
 21 p0040 A79-11819

Molten-carbonate CO<sub>2</sub> concentrator - Preliminary  
 experiments  
 [ASME PAPER 78-ENAS-2] 21 p0048 A79-12551

Vaporization of drops of a melt of potassium  
 carbonate in a medium of combustion products  
 21 p0167 A79-20411

Steady-state composition profiles in mixed molten  
 salt electrochemical devices. II - Molten  
 carbonate fuel cell analogs  
 22 p0305 A79-30333

**CARBONIZATION**

Fluid-bed carbonization/desulfurization of  
 Illinois coal by the Clean Coke Process - PDU  
 studies --- Process Development Unit  
 21 p0045 A79-12121

The role of fundamental combustion in the future  
 aviation fuels program --- carbon formation in  
 gas turbine primary zones  
 21 p0202 A79-13195

**CARGO AIRCRAFT**

Vehicle Design Evaluation Program (VDEP). A  
 computer program for weight sizing, economic,  
 performance and mission analysis of  
 fuel-conservative aircraft, multibodied aircraft  
 and large cargo aircraft using both JP and  
 alternative fuels  
 [NASA-CR-145070] 21 p0200 A79-13026

**CARGO SHIPS**

Sail power for the world's cargo ships  
 22 p0305 A79-30374

**CARBOT CYCLE**

Reversible thermoelectric power conversion of  
 energy fluctuations  
 22 p0261 A79-23619

Production of mechanical energy by thermodynamic  
 conversion of solar energy  
 22 p0310 A79-30999

**CASCADE FLOW**

Thermophoresis - Enhanced deposition rates in  
 combustion turbine blade passages  
 [ASME PAPER 78-WA/GT-1] 21 p0160 A79-19790

**CASSEGRAIN OPTICS**

Analysis of a Cassegrain solar furnace  
 22 p0293 A79-28147

**CASTINGS**

Cast semicrystalline silicon for solar cells  
 [ASME PAPER 79-SOL-16] 22 p0309 A79-30550

Silicon sheet growth development for the large  
 area sheet task of the low cost solar array  
 project. Heat exchanger method - ingot casting  
 fixed abrasive method - multi-wire slicing  
 [NASA-CR-158038] 21 p0219 A79-14540

**CATALOGS (PUBLICATIONS)**

International project catalog of modular  
 integrated utility systems  
 [PB-283477/8] 21 p0190 A79-11544

**CATALYSIS**

Prerrefining true in situ shale oil  
 21 p0004 A79-10044

Catalytic gasification predevelopment research  
 21 p0029 A79-10246

Catalysis in coal conversion --- Book  
 21 p0051 A79-12873

The H-Coal project --- catalytic hydrogenation of  
 coal  
 21 p0145 A79-17635

Influence of composition on the activity of  
 tungsten carbide gas diffusion hydrogen electrodes  
 22 p0245 A79-21482

Catalytic hydrodesulfurization and liquefaction of  
 coal - Batch autoclave studies  
 22 p0282 A79-26465

Coal gasification studies. I - Single stage  
 complete gasification of coal using water as the  
 hydrogen source  
 22 p0283 A79-26466

**CATALYSTS**

Catalytic coal gasification exploratory research  
 program  
 21 p0030 A79-10247

The Dow Chemical liquefaction process  
 21 p0147 A79-17644

Evaluation of commercial catalysts for the  
 Fischer-Tropsch reaction --- for coal conversion  
 to liquid fuel or chemical feedstock  
 22 p0272 A79-25124

Coal gasification studies. II - Reduction in the  
 presence of I<sub>2</sub> with H<sub>2</sub>, and H<sub>2</sub>O/+/- metal, at  
 pressures up to 3500 p.s.i. and temperatures of  
 600 C in all quartz reactors  
 22 p0283 A79-26468

Coke formation on hydrodesulphurization catalysts  
 22 p0283 A79-26470

Catalyst development program for  
 hydrodesulfurization and liquefaction of coal to  
 produce clean boiler fuels  
 [FE-2321-12] 21 p0216 A79-14240

Methane production from carbon oxides over  
 borohydride-reduced transition metals  
 [PB-286385/0] 21 p0226 A79-15177

Demetalization catalyst tests on heavy residual  
 oils  
 [PB-285937/9] 21 p0232 A79-15864

Catalyst aging tests and the role of catalyst  
 wetting on hydrodesulfurization of a coal  
 derived liquid  
 22 p0352 A79-19169

**CATALYTIC ACTIVITY**

Effect of inlet temperature on the performance of  
 a catalytic reactor  
 21 p0035 A79-11542

Generation of electrical energy from hydrogen and  
 oxygen by means of fuel cells  
 21 p0059 A79-13662

Correlations of catalytic combustor performance  
 parameters  
 21 p0081 A79-14956

The influence of lead compounds on automotive  
 exhaust catalysts  
 21 p0116 A79-17253

Rare earth and actinide intermetallics as  
 hydrogenation catalysts  
 22 p0251 A79-21713

Hydrogen storage in FeTi - Surface segregation and  
 its catalytic effect on hydrogenation and  
 structural studies by means of neutron diffraction  
 22 p0312 A79-31156

Catalytic conversion of coal energy to hydrogen  
 [FE-2206-14] 21 p0180 A79-11239

Catalytic effect of Ni and K<sub>2</sub>CO<sub>3</sub> in the  
 gasification of carbon and coal  
 22 p0364 A79-21215

**CAVITIES**

Cavity-type surfaces for solar collectors  
 22 p0283 A79-26497

**CELL ANODES**

n-CdS/n-GaAs photoanode --- electrochemical solar  
 cells  
 21 p0037 A79-11784

Measuring the quasi-Fermi level and flat band  
 potential of an illuminated Au/n-GaAs/.6/Fe/.4/  
 anode --- for solar cells  
 22 p0317 A79-31411

**CELL CATHODES**

Silver selenate and silver tellurate as positive  
 materials for lithium primary power sources  
 22 p0245 A79-21484

On the possibility of using silver salts other  
 than Ag<sub>2</sub>CrO<sub>4</sub> in organic lithium cells  
 22 p0246 A79-21491

**CELLULOSE**

The Koppelman process --- to upgrade lignite and  
 some waste energy sources  
 21 p0145 A79-17634

**CENTRAL AMERICA**

Opportunities for direct use of geohat in Central  
 America and other tropical countries  
 21 p0097 A79-16074



## CENTRIFUGAL COMPRESSORS

Advanced industrial gas turbine cooling and high pressure compressor technology 21 p0004 A79-10041

## CERAMIC COATINGS

Metallurgical coatings 1978; Proceedings of the Fifth International Conference, San Francisco, Calif., April 3-7, 1978. Volumes 1 & 2 22 p0327 A79-31951  
 Selective-black absorbers using sputtered cermet films 22 p0327 A79-31969

## CERAMICS

Characteristics of combustion-heated thermionic diodes 21 p0026 A79-10215  
 Ceramic components for vehicular gas turbines 21 p0034 A79-11150  
 Test and development of ceramic combustors, stators, nose cones, and rotor tip shrouds 21 p0049 A79-12821  
 Reliability and durability of ceramic regenerators for gas turbine applications 21 p0050 A79-12823  
 Ceramic heat exchanger - Applications and developments 21 p0050 A79-12826  
 Development of ceramic parts for a truck gas turbine at MTU 21 p0050 A79-12831  
 Development of multi-density silicon nitride turbine rotors 21 p0050 A79-12832  
 Preliminary design of a subscale ceramic helical-rotor expander 21 p0050 A79-12849  
 Ceramics for the advanced automotive gas turbine engine - A look at a single shaft design 21 p0050 A79-12850  
 Ceramic applications in the advanced Stirling automotive engine 21 p0051 A79-12851  
 Program to establish ceramic technology readiness for large combustion turbine utility application [ASME PAPER 78-WA/GT-8] 21 p0160 A79-19796  
 Ceramic materials for vehicular gas turbine applications 21 p0165 A79-20085  
 Preliminary analysis of advanced ceramic magnetohydrodynamic /MHD/ combustor design concepts 22 p0240 A79-20838  
 Ceramic technology readiness program [FE-2664-7] 21 p0180 N79-11223  
 Tests of NASA ceramic thermal barrier coating for gas-turbine engines [NASA-TN-79116] 22 p0357 N79-20118  
 MHD power generation: Research, development and engineering [FE-3087-2] 22 p0363 N79-20518  
 Evaluation of ceramics for stator application: Gas turbine engine report [NASA-CR-159533] 22 p0364 N79-21075  
 Development, characterization and evaluation of materials for open cycle MHD [PNL-2004-8] 22 p0369 N79-21557

## CERMETS

Gold, silver, chromium, and copper cermet selective surfaces for evacuated solar collectors 22 p0256 A79-22855  
 Selective-black absorbers using sputtered cermet films 22 p0327 A79-31969

## CESIUM PLASMA

Radiatively sustained cesium plasmas for solar electric conversion 21 p0109 A79-16615  
 Magnetically confined plasma solar collector --- satellite based system in space 21 p0109 A79-16617  
 Optimization of a Knudsen Cs-Ba thermionic converter 22 p0241 A79-20940

## CHALCOGENIDES

Low voltage behavior of lithium/metal dichalcogenide topochemical cells 22 p0286 A79-26995

## CHANNEL FLOW

Channel No. 1 of the MHD generator of a U-25B unit for carrying out investigations in strong electric and magnetic fields 21 p0049 A79-12693  
 Attenuating the transverse edge effect in MHD generators 21 p0063 A79-13985  
 Supersonic flow in an MHD channel with a downwash flow at the inlet 21 p0085 A79-15342  
 Effect of force field nonuniformity on flow in an MHD channel 21 p0101 A79-16365  
 Effect of finite boundary layer on the ionization instability in non-equilibrium MHD generators 21 p0153 A79-18469  
 Slag deposition and its effect on the performance of MHD channels --- in electric generators [AIAA PAPER 79-0189] 21 p0157 A79-19588  
 Subsonic flow in the channel of an MHD-generator 21 p0167 A79-20413  
 Turbulence of a combustion product plasma in an MHD channel 22 p0246 A79-21538  
 Nonstationary two-dimensional magnetohydrodynamic flow in a radial channel 22 p0247 A79-21626  
 Optimization of a diagonal MHD channel 22 p0247 A79-21628  
 Two-dimensional MHD channel design --- for energy performance improvement at lower wall temperature 22 p0279 A79-26183  
 Subsonic diffusers for MHD generators 22 p0279 A79-26185  
 Comparison of results of calculation of flow in an MHD generator with experimental data obtained on the U-25 device 22 p0306 A79-30392  
 Combustion of hydrogen in a supersonic flow in a channel in the presence of a pseudodiscontinuity 22 p0324 A79-31845  
 Parametric study of the performance of a CDIF 1-B coal-fired MHD generator [ANL-MHD-79-3] 22 p0361 A79-20503  
**CHARGE CARRIERS**  
 Spectral characteristics of photoconverters with nonuniform defect distribution in the base 21 p0053 A79-13289  
**CHARGE DISTRIBUTION**  
 A state of charge monitor for sealed lead-acid cells [ATR-78(8114)-2] 21 p0220 N79-14558  
**CHARGE TRANSFER**  
 Electrocatalysis, charge-transfer and the states of H adsorption in the hydrogen evolution reaction 21 p0038 A79-11801  
 Charge transfer by surface states in the photoelectrolysis of water using a semiconductor electrode 22 p0254 A79-22320  
**CHARGED PARTICLES**  
 Single-particle behaviour in plasmas 22 p0257 A79-22977  
**CHARGING**  
 Rapid, efficient charging of lead-acid and nickel-zinc traction cells --- for electric vehicles 21 p0009 A79-10084  
**CHELATES**  
 On the mechanism of the electrocatalytic oxygen reduction with particular regard to metal chelates --- in fuel cell electrodes 21 p0038 A79-11808  
**CHEMICAL ANALYSIS**  
 Study of diffusion processes in low-temperature thermopiles --- for solar energy conversion 21 p0054 A79-13290  
 Chemical studies of stack fly ash from a coal-fired power plant 22 p0309 A79-30595  
 Chemicals from coal. Report based on BRI B-coal product [FE-1534-50] 21 p0180 N79-11166  
 Evaluation of the application of some gas chromatographic methods for the determination of properties of synthetic fuels [NASA-TN-79035] 22 p0338 N79-16930

# CHEMICAL ATTACK

# SUBJECT INDEX

## CHEMICAL ATTACK

Investigation of the corrosion performance of boiler, air heater, and gas turbine alloys in fluidized combustion systems 21 p0080 A79-14931

## CHEMICAL BONDS

Structure and bonding in metal hydrides 22 p0247 A79-21679

## CHEMICAL CLEANING

Trace element characterization and removal/recovery from coal and coal wastes [LA-7048-PR] 21 p0222 A79-14602

## CHEMICAL COMPOSITION

The zinc electrode in sealed alkaline cells 21 p0040 A79-11823

Alternative aviation turbine fuels 21 p0047 A79-12378

Effect of broadened-specification fuels on aircraft engines and fuel systems [AIAA 79-7008] 22 p0300 A79-29383

Coal anion structure and chemistry of coal alkylation [COO-4227-2] 21 p0170 A79-10178

Identification of probable automotive fuels consumption: 1985-2000, executive summary [HCP/W3684-01/2] 21 p0194 A79-12249

Identification of probable automotive fuels composition: 1985-2000 [HCP/W3684-01/1] 21 p0201 A79-13191

## CHEMICAL ENERGY

Basic physical and chemical processes for storage of heat 21 p0038 A79-11805

Chemically driven heat pumps for solar thermal storage 21 p0120 A79-17316

Alternative forms of energy transmission from OTEC plants 21 p0141 A79-17505

New chemical sources of current --- Russian book 22 p0237 A79-20679

HYCSOS - A system for evaluation of hydrides as chemical heat pumps 22 p0252 A79-21716

Hybrid chemical concept for solar energy storage 22 p0254 A79-22271

## CHEMICAL ENGINEERING

Engineering analysis of in situ liquefaction of coal 21 p0032 A79-10521

Chemical production from waste carbon monoxide: Its potential for energy conservation [BNWL-2137] 21 p0170 A79-10179

## CHEMICAL EXPLOSIONS

Differential scanning calorimetry studies of possible explosion-causing mixtures in Li/SO<sub>2</sub> cells 22 p0246 A79-21487

## CHEMICAL PROPERTIES

Investigation of physical and chemical properties of phase change materials for space heating/cooling applications 21 p0120 A79-17319

Definition of chemical and electrochemical properties of a fuel cell electrolyte [AD-A058795] 21 p0206 A79-13503

Compilation of level 1 environmental assessment data [PB-286924/6] 22 p0336 A79-16439

## CHEMICAL REACTIONS

A thermochemical energy storage system and heat pump 21 p0012 A79-10105

Electrocatalysis, charge-transfer and the states of H adsorption in the hydrogen evolution reaction 21 p0038 A79-11801

Liquid-phase reactions of vaporizing hydrocarbon fuels 21 p0052 A79-12987

## CHEMICAL REACTORS

Effect of inlet temperature on the performance of a catalytic reactor 21 p0035 A79-11542

Selection of thermal operating regimes for fuel cell reactor-condenser systems 21 p0165 A79-20342

Coal gasification studies. II - Reduction in the presence of I<sub>2</sub> with H<sub>2</sub>, and H<sub>2</sub>O/+/- metal, at pressures up to 3500 p.s.i. and temperatures of 600 C in all quartz reactors 22 p0283 A79-26468

Catalyst development program for hydrodesulfurization and liquefaction of coal to produce clean boiler fuels [FE-2321-12] 21 p0216 A79-14240

Development of a model and computer code to describe solar grade silicon production processes --- phase changes in chemical reactors [NASA-CR-158037] 21 p0219 A79-14555

## CHLORIDES

Chloride corrosion and its inhibition in refuse firing 21 p0080 A79-14930

Sodium-antimony trichloride battery development program for load leveling [EPRI-EM-751] 21 p0186 A79-11501

## CHLORINATION

Coal desulfurization by low-temperature chlorinolysis 21 p0045 A79-12119

## CHLOROPHYLLS

Harvesting solar energy using biological systems 21 p0126 A79-17372

Highly efficient quantum conversion at chlorophyll a-lecithin mixed monolayer coated electrodes --- for solar energy conversion 22 p0273 A79-25548

## CHLOROPLASTS

Synthetic chloroplasts --- for photosynthetic solar energy conversion 22 p0262 A79-23721

Biological solar energy conversion: Approaches to overcome yield, stability and product limitations [PB-286487/4] 21 p0230 A79-15422

## CHLOROSILANES

Possibility of production of low cost solar grade silicon by trichlorosilane process 21 p0125 A79-17363

## CHROMIUM

New processes for black coatings useful in harnessing solar energy. I - A room temperature black chromium plating bath 21 p0127 A79-17379

Selective absorption of solar energy by ultrafine metal particles 21 p0127 A79-17382

Spectral selective properties of black chrome and nickel electrodeposited coatings for solar absorber 21 p0127 A79-17383

Microstructure dependence of the optical properties of solar-absorbing black chrome 22 p0256 A79-22858

Selective absorption of solar energy in ultrafine metal particles - Model calculations 22 p0273 A79-25746

Optimization studies on black chrome electroplating variables for solar selective surfaces 22 p0317 A79-31407

Supply of reactants for Redox bulk energy storage systems [NASA-TN-78995] 21 p0183 A79-11479

## CIRCUIT RELIABILITY

High reliability contacts for miniature thermoelectric converters 21 p0027 A79-10228

## CIRCUITS

Power management and control for space systems 21 p0170 A79-10134

## CIRCULAR CONES

Comparison of the solar concentrating properties of truncated hexagonal, pyramidal and circular cones 21 p0043 A79-11974

## CIRCULAR CYLINDERS

Comparative performance of tracking type and non-tracking type solar collectors 21 p0136 A79-17454

## CIRCULAR TUBES

Solids mixing and fluidization characteristics in a tube filled bed --- of fluidized bed coal combustion 21 p0008 A79-10070

Optimum tube pitch in solar collectors 21 p0132 A79-17421

# SUBJECT INDEX

COAL

## CIRCUMSOLAR RADIATION

The circumsolar measurement program - Assessment of the effects of atmospheric scattering on solar energy conversion 21 p0082 A79-15077

## CITIES

Energy from urban waste 21 p0096 A79-15917  
Comparative outdoor measurements on flat-plate solar collectors in a metropolitan area in Western Germany 21 p0128 A79-17394

Planning program to accelerate energy conservation in municipalities [HCE/805017-01/1] 21 p0210 A79-13536  
Baltimore applications project [NASA-TS-79667] 22 p0351 A79-18815

## CIVIL AVIATION

Impact of fuel availability and other cost trends on air carrier operations 21 p0053 A79-13077  
Pilot's view of the evolving air transport 21 p0053 A79-13085  
Technology for aircraft energy efficiency 21 p0066 A79-14136  
Alternate aircraft fuels prospects and operational implications 21 p0066 A79-14138  
Prospects for reducing the fuel consumption of civil aircraft 22 p0325 A79-31911

## CLASSIFICATIONS

Energy information data base. Guide to abstracting and indexing [TID-4583-R1] 21 p0184 A79-11488

## CLEAN ENERGY

Coal desulfurization: Chemical and physical methods; Proceedings of the Symposium, New Orleans, La., March 23, 1977 21 p0044 A79-12114  
An overview of coal preparation --- for producing clean fuel through desulfurization 21 p0044 A79-12115

German Solar Energy Forum, 1st, Hamburg, West Germany, September 26-28, 1977, Proceedings. Volume 2 1 to 20 21 p0055 A79-13619

Fuel-cell power plants 21 p0068 A79-14398

Particulate and sulfur oxide control options for conventional coal combustion 21 p0092 A79-15883

Development of central station power plants integrated with coal gasifiers --- utilizing molten-carbonate fuel cells 21 p0093 A79-15895

Ocean energy unlimited --- water wave conversion 21 p0095 A79-15908

Hot dry rock, an abundant clean energy resource 21 p0098 A79-16106

A proposed conceptual plan for integration of wind turbine generators with a hydroelectric system 21 p0098 A79-16107

International Symposium-Workshop on Solar Energy, Cairo, Egypt, June 16-22, 1978, Symposium Lectures 21 p0102 A79-16451

Solar-hydrogen energy system and solar-hydrogen production methods 21 p0104 A79-16463

Tidal power plants - Sites, history and geographical distribution 21 p0150 A79-18102

Wind power and other energy options --- Book 21 p0153 A79-18346

Burn coal cleanly in a fluidized bed - The key is in the controls 22 p0282 A79-26374

The use of ocean energy - A hydrostatic motor 22 p0288 A79-27391

An operating 200-kW horizontal axis wind turbine [NASA-TS-79034] 22 p0333 A79-16357

## CLEAN FUELS

Economic evaluation of the APC/Wellman incandescent two-stage low Btu coal gas producer 21 p0146 A79-17640

Upgrading lignite by the Koppelman process 21 p0146 A79-17641

Synthetic fuels from Gulf Coast lignite 21 p0146 A79-17643

The Dow Chemical liquefaction process

Kinetic modeling of pyrolysis and hydrogasification of carbonaceous materials --- converting wood waste char to clean fuels 21 p0147 A79-17644  
21 p0179 A79-11150

## CLEANING

EPA program conference report: Coal cleaning, an option for Increased Coal Utilization [PB-288223/1] 22 p0344 A79-17378  
Interagency coal cleaning technology development 22 p0347 A79-18361  
Assessment of coal cleaning technology: An evaluation of chemical coal cleaning processes [PB-289493/9] 22 p0372 A79-21625

## CLIMATE

Optimum collector slope for residential heating in adverse climates 22 p0263 A79-23761  
Phase one/base data for the development of energy performance standards for new buildings. Climatic classification [PB-286900/6] 22 p0336 A79-16497  
Geographical variation in the heating and cooling requirements of a typical single-family house, and correlation of these requirements to degree days [PB-289204/0] 22 p0355 A79-19467

## CLIMATOLOGY

The effects of different energy strategies on the atmospheric CO2 concentration and climate 21 p0106 A79-16523  
Climatic change in connection with energy growth --- resource consumption effects 22 p0284 A79-26623  
Solutions to energy conservation in northern climates 22 p0321 A79-31443  
Multidisciplinary research related to the atmospheric sciences [PB-283076/8] 21 p0179 A79-10679

## CLOSED CYCLES

Closed Cycle Gas Turbine power generation opportunities 21 p0004 A79-10039  
Ceramic heat exchanger - Applications and developments 21 p0050 A79-12826  
The nuclear closed-cycle gas turbine /GT-HTGR/ - A utility power plant for the year 2000 [AIAA PAPER 79-0191] 21 p0157 A79-19590  
Performance of a closed-cycle MHD generator with molecular impurities 22 p0283 A79-26524  
Cogeneration in Europe and the combined cycle gas turbine 22 p0297 A79-28988  
Conceptual design of a solar powered closed-cycle gas turbine electric power generation system [ASME PAPER 79-GT-43] 22 p0306 A79-30522  
Investigation of the heat transfer in cylindrical receiver configurations with inner tubes [ASME PAPER 79-GT-64] 22 p0306 A79-30532  
Closed cycle gas turbines, volume 1 [VKI-LS-100-VOL-1] 22 p0331 A79-16260  
Large closed-cycle gas turbine plant [GA-A-14311] 22 p0331 A79-16261  
Power cycles and working fluids for low temperature heat sources 22 p0332 A79-16268

## COAL

Remote sensing and mine subsidence in Pennsylvania 22 p0303 A79-29936  
Coal anion structure and chemistry of coal alkylation [COO-4227-2] 21 p0170 A79-10178  
Proceedings of the Engineering Foundation Conference on Clean Combustion of Coal [PB-282949/7] 21 p0171 A79-10243  
Application of multispectral scanner data to the study of an abandoned surface coal mine [NASA-TS-78912] 21 p0204 A79-13472  
A synoptic description of coal basins via image processing [NASA-CR-157970] 21 p0204 A79-13474  
Coal desulfurization using microwave energy [PB-285880/1] 21 p0216 A79-14243

## COAL GASIFICATION

## SUBJECT INDEX

- Source assessment: Water pollutants from coal storage areas [PB-285420/6] 21 p0223 N79-14635
- Proceedings of Energy Resource 5th Conference [PB-286246/4] 21 p0230 N79-15423
- GAO work involving title V of the Energy Policy and Conservation Act of 1975 [PB-286400/7] 21 p0230 N79-15424
- Combustion research on the fate of fuel-nitrogen under conditions of pulverized coal combustion [PB-286208/4] 21 p0232 N79-15474
- Assessment of coal cleaning technology [PB-287091/3] 22 p0330 N79-16139
- Application of LANDSAT data and digital image processing --- Ruhr Valley, Germany [E79-10102] 22 p0339 N79-17291
- Reservoir ecosystems and western coal development in the upper Missouri River Basin [PB-287363/6] 22 p0339 N79-17309
- Atlas of western surface-mined lands: Coal, uranium, and phosphate [PB-287846/0] 22 p0340 N79-17311
- Coal preparation design for export markets, with particular reference to South African and Canadian coals 22 p0340 N79-17318
- Influence of marketing requirements on definition of coal resources 22 p0340 N79-17319
- EPA program conference report: Coal Cleaning, an Option for Increased Coal Utilization [PB-288223/1] 22 p0344 N79-17378
- Interagency coal cleaning technology development 22 p0347 N79-18361
- Catalyst aging tests and the role of catalyst wetting on hydrosulfurization of a coal derived liquid 22 p0352 N79-19169
- Methane utilization from coalbeds for power generation [PB-288408] 22 p0352 N79-19171
- Source assessment: Open mining of coal. State of the Art [PB-288497/1] 22 p0353 N79-19429
- Assessment of coal cleaning technology: An evaluation of chemical coal cleaning processes [PB-289493/9] 22 p0372 N79-21625
- Pollution control guidelines for coal refuse piles and slurry ponds [PB-291369/7] 22 p0373 N79-21682
- COAL GASIFICATION**
- Design considerations for an in situ gasification test of eastern bituminous coals 21 p0005 A79-10049
- Instrumentation development for in situ coal gasification 21 p0006 A79-10053
- Coal conversion by flash hydrolysis and hydrogasification 21 p0006 A79-10055
- Synthane - A process for the gasification of caking and noncaking coals 21 p0006 A79-10057
- Process development for the Westinghouse advanced fluidized-bed coal gasification system 21 p0006 A79-10058
- Theoretical studies of coal pyrolysis in an entrained bed flow reactor 21 p0007 A79-10063
- Computer aided optimization of integrated coal gasification combined cycle power plants 21 p0008 A79-10075
- Low-Btu gas from the IGT ash-agglomeration gasification process 21 p0009 A79-10077
- Catalytic gasification predevelopment research 21 p0029 A79-10246
- Catalytic coal gasification exploratory research program 21 p0030 A79-10247
- Instrumentation for in situ coal gasification. II - Thermal and gas sampling diagnostic techniques 21 p0032 A79-10520
- Underground coal gasification research at the University of New Mexico 21 p0032 A79-10523
- Second-generation integrated coal gasification/combined-cycle power systems [ASME PAPER 78-GT-14] 21 p0032 A79-10778
- Desulfurization and sulfidation of coal and coal char 21 p0045 A79-12120
- Ambient air quality assessment of the Synthane coal gasification pilot plant, six month study /August 1976-January 1977/ 21 p0064 A79-14113
- Coal gasification and its alternatives 21 p0071 A79-14679
- Shock tube studies of coal devolatilization 21 p0083 A79-15247
- Risk control in the development of energy processes --- environment, worker and capital considerations in coal gasification 21 p0085 A79-15372
- H-Coal pilot plant project and status of commercial development at Ashland --- coal gasification producing hydrogen and hydrocarbons 21 p0092 A79-15888
- Development of central station power plants integrated with coal gasifiers --- utilizing molten-carbonate fuel cells 21 p0093 A79-15895
- SWG production by the Rockgas process 21 p0093 A79-15896
- Incentives and requirements for gasification based power systems 21 p0094 A79-15904
- Integrated low Btu gasification, combined cycle plant considerations and control 21 p0094 A79-15905
- Production and use of low and medium Btu gas 21 p0095 A79-15912
- Westinghouse fluidized bed coal gasification system - Experience and plans 21 p0096 A79-15924
- A methodological note on the evaluation of new technologies - The case of coal gasification 21 p0099 A79-16122
- Gasification Combined Cycle Test Facility at Pekin, Illinois 21 p0145 A79-17632
- Advances in fluidized bed gasification process development 21 p0145 A79-17633
- Synthetic fuels from coal to noise 21 p0145 A79-17636
- Economic evaluation of the ATC/Wellman incandescent two-stage low Btu coal gas producer 21 p0146 A79-17640
- Underground gasification of coal at deep levels - Perspectives and problems 21 p0156 A79-19401
- A theoretical study of wood gasification processes 22 p0257 A79-22923
- Synthetic oil from coal - The economic impact of five alternatives for making hydrogen from coal and steam 22 p0262 A79-23719
- Substitute natural gas from coal using high-temperature reactor heat - Project 'Prototype Plant Nuclear Process Heat' 22 p0264 A79-23827
- Gasification of coal with high-temperature reactor heat - Investigations concerning the market and the economics 22 p0264 A79-23828
- Methane formation during the hydrogasification and the gas phase pyrolysis of defined aromatics 22 p0265 A79-23829
- Flow modeling of an atmospheric pressure, entrained-type coal gasifier 22 p0280 A79-26188
- Modeling two-phase flow in a swirl combustor 22 p0280 A79-26189
- Wilson parameters for the system H<sub>2</sub>, N<sub>2</sub>, CO, CO<sub>2</sub>, CH<sub>4</sub>, H<sub>2</sub>S, CH<sub>3</sub>OH, and H<sub>2</sub>O --- for cold methanol absorption in coal gasification 22 p0282 A79-26462
- Coal gasification studies. I - Single stage complete gasification of coal using water as the hydrogen source 22 p0283 A79-26466
- A mass and energy balance of a Wellman-Galusha gasifier --- bituminous coal conversion 22 p0283 A79-26467

# SUBJECT INDEX

# COAL LIQUEFACTION

- Coal gasification studies. II - Reduction in the presence of  $H_2$  with  $H_2$ , and  $H_2O$  metal, at pressures up to 3500 p.s.i. and temperatures of 600 C in all quartz reactors 22 p0283 A79-26468
- Sampling and analysis of synthetic fuel processes --- coal gasification and liquefaction effluent analysis 22 p0284 A79-26538
- Hot corrosion of Ni-base turbine alloys in atmospheres in coal-conversion systems 22 p0288 A79-27395
- Hydrogen via gasification - Today and tomorrow 22 p0289 A79-27652
- Lignite - Abundant raw material of the future 22 p0296 A79-28438
- Feasible operating regions for moving bed coal gasification reactors 22 p0297 A79-28983
- The economics of hydrogen and carbon monoxide separation with cuprous ammonium lactate solutions --- hydrogen production from coal 22 p0299 A79-29313
- Coal gasification studies. III - Reduction in the presence of some metal iodides and iron halides 22 p0299 A79-29314
- Energy conversion engineering --- Book 22 p0302 A79-29575
- Instrumentation for in situ coal gasification. IV - Seismic and acoustic techniques for remote monitoring 22 p0304 A79-29974
- Study of integrated gasification combined cycle plant interaction and control [ASME PAPER 79-GT-60] 22 p0306 A79-30530
- Gasification of raw lignite in the tube-furnace gasifier 22 p0310 A79-30996
- Low NOx combustion concepts for advanced power generation systems firing low-Btu gas [PB-282983/6] 21 p0178 A79-10610
- Economics of fuel gas from coal: An update including the British Gas Corporation's slagging gasifier [EPRI-AP-782] 21 p0180 A79-11238
- Catalytic conversion of coal energy to hydrogen [FE-2206-14] 21 p0180 A79-11239
- Economics of Texaco gasification: Combined cycle systems. Economic studies of coal gasification combined cycle systems for electric power generation [EPRI-AP-753] 21 p0185 A79-11498
- Environmental Development Plan (EDP): Underground coal conversion program, FY 1977 [DOE/EDP-0011] 21 p0192 A79-11569
- Measurement of high-temperature, high-pressure processes [PB-284041/1] 21 p0195 A79-12424
- Guidelines for preparing environmental test plans for coal gasification plants [PB-286659/8] 21 p0232 A79-15479
- Thermoelastic solutions for in-situ gasification of coal 22 p0330 A79-16135
- Modelling and control of a fluidized bed gasifier 22 p0332 A79-16345
- Pollutants from synthetic fuels production: Facility construction and preliminary tests --- coal gasification plant effluents [PB-287730/6] 22 p0339 A79-17027
- Coal gasification and South Africa 22 p0340 A79-17321
- Environmental assessment data base for high-Btu gasification technology. Volume 1: Technical discussion [PB-288602/6] 22 p0350 A79-18487
- Environmental assessment data base for high-Btu gasification technology. Volume 2: Appendices A, B, and C [PB-288603/4] 22 p0350 A79-18488
- Environmental assessment data base for high-Btu gasification technology. Volume 3: Appendices D, E, and F [PB-288604/2] 22 p0350 A79-18489
- Water-related environmental effects in fuel conversion, volume 1. Summary [PB-288313/0] 22 p0351 A79-18834
- Applicability of petroleum refinery control technologies to coal conversion [PB-288630/7] 22 p0352 A79-19173
- Water-related environmental effects in fuel conversion. Volume 2: Appendices [PB-288874/1] 22 p0356 A79-19496
- Catalytic effect of  $H_2$  and  $K_2CO_3$  in the gasification of carbon and coal 22 p0364 A79-21215
- Environmental assessment: Source test and evaluation report, Chapman low-Btu gasification [PB-289940/9] 22 p0373 A79-21662
- Air quality impacts using SRC versus conventional coal in power plants [PB-290237/7] 22 p0373 A79-21671
- COAL LIQUEFACTION
- Coal conversion by flash hydrolysis and hydrogasification 21 p0006 A79-10055
- H-coal products for direct application to power generation --- coal liquefaction derived fuels 21 p0006 A79-10056
- Gasification of coal liquefaction residues 21 p0006 A79-10059
- Exxon Donor Solvent coal liquefaction process development 21 p0007 A79-10060
- Coal liquefaction - Status and new directions 21 p0007 A79-10062
- Scaling up coal liquids 21 p0031 A79-10475
- Engineering analysis of in situ liquefaction of coal 21 p0032 A79-10521
- Investigating combustion turbine burner performance with coal derived liquids having high fuel bound nitrogen [ASME PAPER 78-GT-126] 21 p0033 A79-10791
- Fluid-bed carbonization/desulfurization of Illinois coal by the Clean Coke Process - PDD studies --- Process Development Unit 21 p0045 A79-12121
- SRC-II - Review of development and status --- Solvent Refined Coal process for fuel oil production 21 p0092 A79-15887
- Status and outlook of the Exxon Donor Solvent coal liquefaction process development 21 p0092 A79-15889
- Coal-based electricity and air pollution control - A case for solvent refined coal 21 p0096 A79-15922
- The H-Coal project --- catalytic hydrogenation of coal 21 p0145 A79-17635
- Synthetic fuels from coal 21 p0145 A79-17636
- Synthetic fuels from Gulf Coast lignite 21 p0146 A79-17643
- The Dow Chemical liquefaction process 21 p0147 A79-17644
- Synthetic oil from coal - The economic impact of five alternatives for making hydrogen from coal and steam 22 p0262 A79-23719
- Failure analysis in coal conversion systems --- pilot plant for liquefaction 22 p0266 A79-24137
- Evaluation of commercial catalysts for the Fischer-Tropsch reaction --- for coal conversion to liquid fuel or chemical feedstock 22 p0272 A79-25124
- Moessbauer spectroscopy of iron in coal and coal hydrogenation products 22 p0282 A79-26464
- Catalytic hydrodesulfurization and liquefaction of coal - Batch autoclave studies 22 p0282 A79-26465
- Bituminous coal extraction in terms of electron-donor and -acceptor interactions in the solvent/coal system 22 p0283 A79-26469
- Sampling and analysis of synthetic fuel processes --- coal gasification and liquefaction effluent analysis 22 p0284 A79-26538
- Reaction mechanism of alkali-alcohol treatment of coal 22 p0299 A79-29315

# COAL UTILIZATION

# SUBJECT INDEX

Energy conversion engineering --- Book 22 p0302 A79-29575

Aviation fuels from coal 22 p0325 A79-31913

Phase equilibria in coal hydrogenation systems [FE-2334-6] 21 p0171 A79-10238

Standards of Practice Manual for the solvent refined coal liquefaction process [PB-283028/9] 21 p0178 A79-10595

Surfactant-assisted liquefaction of particulate carbonaceous substances [NASA-CASE-NPO-13904-1] 21 p0179 A79-11152

Chemicals from coal. Report based on HRI R-coal product [FE-1534-50] 21 p0180 A79-11166

Catalyst development program for hydrodesulfurization and liquefaction of coal to produce clean boiler fuels [FE-2321-12] 21 p0216 A79-14240

Coal liquefaction support studies. Task 1: Heat of reaction of hydrogen with coal slurries. Task 2: Heat transfer coefficient [ANL/CEW/FE-77-5] 21 p0216 A79-14242

Catalyst evaluation for denitrogenation of petroleum residua and coal liquids, phase 5 [PB-287180/4] 22 p0339 A79-17026

Environmental assessment data base for coal liquefaction technology. Volume 1: Systems for 14 liquefaction processes [PB-287799/1] 22 p0344 A79-17364

Environmental assessment data base for coal liquefaction technology. Volume 2: Synthoil, R-coal, and Exxon donor solvent processes [PB-287800/7] 22 p0344 A79-17365

Water-related environmental effects in fuel conversion, volume 1. Summary [PB-288313/0] 22 p0351 A79-18834

**COAL UTILIZATION**

Coal-fired gas turbine power cycles with steam reagent injection 21 p0004 A79-10042

Underground thermal generation of hydrocarbons from dry, southwestern coals 21 p0005 A79-10050

Electrochemical engines for power generation and load-leveling at sites for underground coal conversion 21 p0005 A79-10051

Status of the DOE underground coal conversion program 21 p0005 A79-10052

Operation of the Ft. Lewis, Washington Solvent Refined Coal /SRC/ Pilot Plant in the SRC I and SRC II processing modes 21 p0006 A79-10054

Exploratory research in coal conversion 21 p0007 A79-10061

New processes for the recovery of resource materials from coal combustion wastes 21 p0007 A79-10065

Fluidized-bed combustion of low-quality fuels 21 p0007 A79-10066

A review of the PFBC combined cycle and its influence on gas turbine design parameters --- Pressurized Fluidized Bed Combustion 21 p0007 A79-10067

Conceptual design and cost estimate 600 MWe coal fired fluidized-bed combined cycle power plant 21 p0008 A79-10068

Factors limiting limestone utilization efficiency in fluidized-bed combustors --- in determining sulfur dioxide emission level 21 p0008 A79-10069

Solids mixing and fluidization characteristics in a tube filled bed --- of fluidized bed coal combustion 21 p0008 A79-10070

Alternatives for coal based power generation - An international overview 21 p0008 A79-10074

Pressurized fluidized-bed combustion/component test and integration unit preliminary design report 21 p0008 A79-10076

The LASH /laser-ash/ particulate fragmentation removal concept for coal fired turbine power plants 21 p0009 A79-10078

Heat exchanger designs for coal-fired fluidized beds 21 p0009 A79-10079

Economic optimization of the coal-fired MHD Steam Power Plant 21 p0016 A79-10134

Thermal modeling of coal-fired MHD plant components 21 p0017 A79-10138

Controlling NOx from a coal-fired MHD process 21 p0017 A79-10139

Design studies and trade-off analyses for a superconducting magnet/MHD power generator system 21 p0017 A79-10142

Underground coal gasification research at the University of New Mexico 21 p0032 A79-10523

Alternative aircraft fuels 21 p0033 A79-10824

Materials problems and opportunities in coal conversion systems 21 p0034 A79-11146

Thin film high temperature solid electrolyte fuel cells 21 p0040 A79-11820

Coal desulfurization: Chemical and physical methods; Proceedings of the Symposium, New Orleans, La., March 23, 1977 21 p0044 A79-12114

An overview of coal preparation --- for producing clean fuel through desulfurization 21 p0044 A79-12115

Desulfurization of coals by high-intensity high-gradient magnetic separation - Conceptual process design and cost estimation 21 p0044 A79-12116

Applicability of the Meyers process for desulfurization of U.S. coal - A survey of 35 coals --- through chemical leaching 21 p0044 A79-12117

Coal desulfurization test plant status - July 1977 --- utilizing Meyers leach process 21 p0044 A79-12118

Coal desulfurization by low-temperature chlorinolysis 21 p0045 A79-12119

Desulfurization and sulfidation of coal and coal char 21 p0045 A79-12120

Fluid-bed carbonization/desulfurization of Illinois coal by the Clean Coke Process - PDU studies --- Process Development Unit 21 p0045 A79-12121

Combustion of porous particles --- coal for MHD generators 21 p0049 A79-12708

Catalysis in coal conversion --- Book 21 p0051 A79-12873

Potential agricultural uses of fluidized bed combustion waste 21 p0064 A79-14108

Advanced processes for generation of electric power - Solvent refining of coal and combined cycle plants 21 p0064 A79-14110

Limestone SO2 reactivity and causes for reactivity loss during multi cycle utilization 21 p0065 A79-14121

Particulate control for coal-fired industrial boilers 21 p0065 A79-14123

The direct reduction of sulfur dioxide 21 p0065 A79-14124

Comparison of nuclear and coal power plants using Net Energy Analysis 21 p0073 A79-14692

The oxidation of sulfur dioxide to sulfate aerosols in the plume of a coal-fired power plant 21 p0076 A79-14757

Chloride corrosion and its inhibition in refuse firing 21 p0080 A79-14930

Investigation of the corrosion performance of boiler, air heater, and gas turbine alloys in fluidized combustion systems 21 p0080 A79-14931

Corrosion of superalloys, inconels, and stainless steels by the products from fluidized-bed coal combustion 21 p0080 A79-14932

# SUBJECT INDEX

# COAL UTILIZATION CONTD

- Coal slag effects in MHD generators 21 p0080 A79-14934
- Corrosion and deposits in MHD generator systems 21 p0081 A79-14935
- Controlled utilization of coal slag in the MHD topping cycle 21 p0081 A79-14936
- The impact of a coal fired power plant on ambient sulfur dioxide levels 21 p0082 A79-15032
- On the depletion of ambient ozone by a rural coal-fired power plant near Portage, Wisconsin 21 p0082 A79-15052
- Particulate and sulfur oxide control options for conventional coal combustion 21 p0092 A79-15883
- SRC-II - Review of development and status --- Solvent Refined Coal process for fuel oil production 21 p0092 A79-15887
- Materials problems and opportunities in coal conversion systems 21 p0094 A79-15900
- Solid waste and coal firing in industrial boilers 21 p0096 A79-15918
- Increasing the efficiency of coal-fired steam electric plants with thermionic topping 21 p0096 A79-15921
- Coal-based electricity and air pollution control - A case for solvent refined coal 21 p0096 A79-15922
- Commercialization of fluidized-bed combustion systems by the State of Ohio 21 p0096 A79-15923
- The atmospheric CO2 consequences of heavy dependence on coal 21 p0107 A79-16524
- Energy requirements of a limestone PGD system --- Flue Gas Desulfurization 21 p0114 A79-16747
- The fate of trace elements in coal after combustion 21 p0116 A79-17250
- Coal technology '78; International Coal Utilization Convention, Houston, Tex., October 17-19, 1978, Conference Papers. Volumes 1 & 2 21 p0145 A79-17631
- The Koppelman process --- to upgrade lignite and some waste energy sources 21 p0145 A79-17634
- Synthetic fuels from coal 21 p0145 A79-17636
- MHD power generation 21 p0146 A79-17638
- A summary of R&D programs --- for coal utilization 21 p0146 A79-17639
- Upgrading lignite by the Koppelman process 21 p0146 A79-17641
- Beneficiation of lignites 21 p0146 A79-17642
- A survey of particulate collection devices for coal-fired boilers 21 p0147 A79-17645
- Coal - Meeting the energy challenge 21 p0147 A79-17647
- Underground gasification of coal at deep levels - Perspectives and problems 21 p0156 A79-19401
- National program for the development of commercial MHD [AIAA PAPER 79-0188] 21 p0157 A79-19587
- Slag deposition and its effect on the performance of MHD channels --- in electric generators [AIAA PAPER 79-0189] 21 p0157 A79-19588
- Recent developments in pressurized fluidized bed coal combustion research [AIAA PAPER 79-0190] 21 p0157 A79-19589
- Combustion of pulverized coal in high temperature preheated air [AIAA PAPER 79-0298] 21 p0158 A79-19654
- Operation and emission of a stoker-fired boiler while burning refuse derived fuel and coal mixtures [ASME PAPER 78-WA/APC-2] 21 p0158 A79-19735
- Combustion modifications for the control of air pollutant emissions from coal fired utility boilers [ASME PAPER 78-WA/APC-7] 21 p0158 A79-19738
- Tests of various coals, coal-oil mixtures and refuse derived fuels in an experimental test facility [ASME PAPER 78-WA/APC-12] 21 p0158 A79-19741
- Trace element emissions from coal-fired power plants [ASME PAPER 78-WA/FU-9] 21 p0160 A79-19789
- Slag transport models for radiant heater of an MHD system [ASME PAPER 78-WA/HT-21] 21 p0161 A79-19808
- Emissions from pressurized fluidized-bed combustion processes 22 p0261 A79-23640
- An approach to automated longwall mining [AIAA PAPER 79-0532] 22 p0274 A79-25871
- Continuous extrusion of coal --- plastic fluidizing process 22 p0282 A79-26372
- Burn coal cleanly in a fluidized bed --- The Key is in the controls 22 p0282 A79-26374
- Open-cycle MHD development --- for power generation 22 p0289 A79-27659
- A model for coal fly ash filtration 22 p0296 A79-28389
- Lignite - Abundant raw material of the future 22 p0296 A79-28438
- A regenerative process for fluidized-bed combustion of coal with lime additives 22 p0297 A79-28984
- Reaction mechanism of alkali-alcohol treatment of coal 22 p0299 A79-29315
- Chemical studies of stack fly ash from a coal-fired power plant 22 p0309 A79-30595
- Aviation fuels from coal 22 p0325 A79-31913
- National coal utilization assessment: An integrated assessment of increased coal use in the midwest: Impacts and constraints, volume 1 [ANL/AA-11-VOL-1-DRAPT] 21 p0174 A79-10537
- Fluidized-bed combustion test of low-quality fuels: Texas lignite and lignite refuse [MERC/RI-78/3] 21 p0175 A79-10543
- Fundamental data needs for coal conversion technology appendices [TID-28152-APP] 21 p0187 A79-11512
- Elemental characteristics of aerosols emitted from a coal-fired heating plant [NASA-TN-78749] 21 p0191 A79-11560
- Energy-related pollutants in the environment: The use of short-term for mutagenicity in the isolation and identification of biohazards [CONF-780121-2] 21 p0192 A79-11568
- Environmental Development Plan (EDP): Underground coal conversion program, FY 1977 [DOE/EDP-0011] 21 p0192 A79-11569
- The department of Defense's alternate energy policy [AD-A058200] 21 p0197 A79-12563
- A Kentucky energy resource utilization program [PB-283796/1] 21 p0198 A79-12574
- Some measures of regional-industrial interfuel substitution potentials [BNL-24368] 21 p0208 A79-13525
- Environmental control implications of generating electric power from coal. Appendix A, part 2: Coal preparation and cleaning assessment study appendix [ANL/ECT-3-APP-A-PT-2] 21 p0213 A79-13571
- Coal loan guarantee program (PL 94-163) [DOE/EIS-0004] 21 p0213 A79-13574
- Environmental effects of increased coal utilization ecological effects of gaseous emission from coal combustion [PB-285440/4] 21 p0213 A79-13591
- Technology and Use of Lignite --- conferences [GPERC/IC-77/1] 21 p0216 A79-14241
- Trace element characterization and removal/recovery from coal and coal wastes [LA-7048-PB] 21 p0222 A79-14602
- Evaluation of electrostatic precipitator during SEC combustion tests [PB-285864/5] 21 p0223 A79-14618
- Analysis of radioactive contaminants in by-products from coal-fired power plant operations [PB-286365/2] 21 p0232 A79-15473
- Coal research: Data systems and information transfer [ORAU-133] 21 p0232 A79-15830

## COASTAL ECOLOGY

## SUBJECT INDEX

Compilation of level 1 environmental assessment data  
[PB-286924/6] 22 p0336 N79-16439

Thermal and kinetic analysis of the pyrolysis of  
coals 22 p0336 N79-16704

Combustion of hydrothermally treated coals  
[PB-287521/9] 22 p0338 N79-17025

EPA program conference report: Coal cleaning, an  
option for Increased Coal Utilization  
[PB-288223/1] 22 p0344 N79-17378

Low-sulfur western coal use in existing small and  
intermediate size boilers --- particulate  
sampling and combustion efficiency  
[PB-287937/7] 22 p0346 N79-18061

Ecological effects of coal-fired steam-electric  
generating stations 22 p0346 N79-18358

Fluidized-bed combustion 22 p0347 N79-18365

Public hearing transcript: Federal non-nuclear  
energy research and development program  
[PB-287910/4] 22 p0349 N79-18464

Environmental impact determination of action to be  
taken under the Energy Supply and Environmental  
Coordination Act for powerplants 1, 2, 3, and 4,  
Portsmouth Generating Station, Portsmouth,  
Virginia [DOE/EA-0033] 22 p0362 N79-20514

A biologist's manual for the evaluation of impacts  
of coal-fired power plants on fish, wildlife and  
their habitats [PB-291330/9] 22 p0373 N79-21679

**COASTAL ECOLOGY**

Environmental impacts of industrial energy systems  
in the coastal zone 21 p0075 A79-14722

ERDA'S oceanographic program for the mid-Atlantic  
coastal region --- impact of offshore energy  
development on coastal ecology [BNL-24016] 21 p0192 N79-11641

Managing oil and gas activities in coastal  
environments [PB-283677/3] 21 p0199 N79-12576

**COATINGS**

Coal slag effects in MHD generators 21 p0080 A79-14934

Accelerated tests for coatings --- for solar  
concentrators 22 p0296 A79-28668

Encapsulation task of the low-cost silicon solar  
array project. Investigation of test methods,  
material properties, and processes for solar  
cell encapsulants, [NASA-CR-157939] 21 p0195 N79-12544

**COBALT ALLOYS**

The effect of induced disorder on the  
hydrogenation behaviour of the phase ZrCo 22 p0251 A79-21707

**COBALT COMPOUNDS**

Development of a satellite flywheel family  
operating on one active axis magnetic bearings 22 p0366 N79-21392

**COHERENT LIGHT**

Direct conversion of solar energy into laser  
radiation 22 p0311 A79-31086

**COHERENT RADIATION**

Generation of the new coherent radiation by  
harmonic conversion and nonlinear mixing for  
certain applications --- optical interactions 21 p0111 A79-16639

**COKE**

Coke formation on hydrodesulphurization catalysts 22 p0283 A79-26470

**COLD FLOW TESTS**

Cold-air performance of free power turbine  
designed for 112-kilowatt automotive gas-turbine  
engine. 2: Effects of variable  
stator-vane-chord setting angle on turbine  
performance [NASA-TN-78993] 22 p0345 N79-17859

**COLD PLASMAS**

Review of results from DITE tokamak 21 p0069 A79-14456

Stabilization of drift loss-cone instability /DCI/  
by addition of cold ions --- in collisional  
hydrogen plasma confinement 22 p0291 A79-27882

**COLD WATER**

Performance testing of a three ton solar  
absorption chiller [ATAA PAPER 78-1757] 21 p0060 A79-13858

**COLD WEATHER**

Solar water heaters for a cold climate 22 p0254 A79-22325

New approaches for the appropriate use of solar  
energy in northern climates 22 p0319 A79-31424

**COLD WEATHER TESTS**

Effects of low ambient temperature on the exhaust  
emissions and fuel economy of 84 automobiles in  
Chicago [PB-288400/5] 22 p0355 N79-19488

**COLLISIONAL PLASMAS**

A collisional plasma rotating between two cylinders 21 p0049 A79-12694

Collisional transport --- particle diffusion and  
heat transport in tokamak 21 p0078 A79-14780

Local theory of finite-beta, collisional drift modes  
--- plasma stability analysis 22 p0253 A79-22244

Collisional transport --- of plasmas in plane and  
toroidal geometry 22 p0257 A79-22980

Integral invariants and quasi-MHD nonlinear  
dissipation --- in magnetized toroidal plasmas 22 p0270 A79-24862

Stabilization of drift loss-cone instability /DCI/  
by addition of cold ions --- in collisional  
hydrogen plasma confinement 22 p0291 A79-27882

Theory of dissipative drift instabilities in  
sheared magnetic fields --- in confined toroidal  
plasmas 22 p0292 A79-27884

Radial transport in the ELMO Bumpy Torus in  
collisional regimes 22 p0312 A79-31184

**COLLISIONLESS PLASMAS**

Stability criteria for current-driven drift wave  
eigenmodes --- in tokamaks 22 p0269 A79-24813

**COLORADO**

Evaluation of high performance evacuated tubular  
collectors in a residential heating and cooling  
system: Colorado State University Solar House 1  
[COO-2577-14] 21 p0206 N79-13507

**COLUMNS (PROCESS ENGINEERING)**

Solar thermal energy storage using heat of  
dilution - Analysis of heat generation in  
multistage mixing column 21 p0046 A79-12271

**COMBUSTION**

Evaluation of the Ames, Iowa refuse derived fuel  
recovery system 21 p0064 A79-14115

Technical notes for the conceptual design for an  
atmospheric fluidized-bed direct combustion  
power generating plant [HCP/T2583-01/2] 21 p0203 N79-13280

**COMBUSTION CHAMBERS**

Pressurized fluidized-bed combustion/component  
test and integration unit preliminary design  
report 21 p0008 A79-10076

Investigating combustion turbine burner  
performance with coal derived liquids having  
high fuel bound nitrogen [ASME PAPER 78-GT-126] 21 p0033 A79-10791

Development of a compact gas turbine combustor to  
give extended life and acceptable exhaust  
emissions [ASME PAPER 78-GT-146] 21 p0033 A79-10799

Stability of combustion in the combustion chamber  
of an MHD generator 21 p0049 A79-12691

Test and development of ceramic combustors,  
stators, nose cones, and rotor tip shrouds 21 p0049 A79-12821

Use of alternative fuels in stationary combustors 21 p0052 A79-12981

Ignition/stabilization/atomization - Alternative  
fuels in gas turbine combustors 21 p0052 A79-12982



# SUBJECT INDEX

# COMBUSTION PRODUCTS

- The fate of fuel nitrogen - Implications for combustor design and operation 21 p0080 A79-14927
- Correlations of catalytic combustor performance parameters 21 p0081 A79-14956
- Fuels and combustion --- for open cycle MHD system 21 p0106 A79-16488
- Technology evolution in the Allison Model 250 engine --- for helicopter propulsion 21 p0155 A79-18681
- Program to establish ceramic technology readiness for large combustion turbine utility application [ASME PAPER 78-WA/GT-8] 21 p0160 A79-19796
- Preliminary analysis of advanced ceramic magnetohydrodynamic /MHD/ combustor design concepts 22 p0240 A79-20838
- Hydrogen enrichment for low-emission jet combustion 22 p0244 A79-21347
- Influences on exhaust emissions from automotive gas turbines [ASME PAPER 78-GT-85] 22 p0255 A79-22338
- Modeling two-phase flow in a swirl combustor 22 p0280 A79-26189
- The application of indirectly fired open cycle gas turbine systems utilizing atmospheric pressure fluidized bed combustors to industrial cogeneration situations [ASME PAPER 79-GT-16] 22 p0306 A79-30510
- A one-dimensional combustion model for a dual chamber stratified charge spark ignition engine [SAE PAPER 790355] 22 p0315 A79-31371
- The influence of overall equivalence ratio and degree of stratification on the fuel consumption and emissions of a prechamber, stratified-charge engine [SAE PAPER 790438] 22 p0315 A79-31375
- The influence of fuel composition on smoke emission from gas-turbine-type combustors - Effect of combustor design and operating conditions 22 p0323 A79-31510
- Development of the combustion chamber of an experimental MHD generator 22 p0327 A79-32105
- Computer modeling of automotive engine combustion [UCBL-80451] 21 p0191 A79-11412
- Parametric performance of a turbojet engine combustor using jet A and A diesel fuel [NASA-TM-79089] 22 p0357 A79-20114
- Simulation of fluidized bed coal combustors [NASA-CR-159529] 22 p0359 A79-20487
- High pressure MHD coal combustors investigation [PE-2706-08] 22 p0362 A79-20510
- Single-cylinder diesel engine tests with unstabilized water-in-fuel emulsions [AD-A062751] 22 p0366 A79-21406
- COMBUSTION CONTROL**
- LAG-Process, some results of utilization in transport and mechanical engineering 21 p0030 A79-10248
- Energy consumption of environmental controls - Fossil fuel, steam electric generating industry 21 p0064 A79-14112
- Combustion modifications for the control of air pollutant emissions from coal fired utility boilers [ASME PAPER 78-WA/APC-7] 21 p0158 A79-19738
- Combustion modification pollutant control techniques for industrial boilers - The influence of fuel oil properties and atomization parameters [ASME PAPER 78-WA/APC-13] 21 p0159 A79-19742
- COMBUSTION EFFICIENCY**
- Fluidized-bed combustion of low-quality fuels 21 p0007 A79-10066
- Combustion rates for oil shale carbonaceous residue 21 p0032 A79-10522
- Alternative fuels for reciprocating internal combustion engines 21 p0051 A79-12980
- Reducing inefficiency and emissions of large steam generators in the United States 21 p0114 A79-17075
- A characteristic time correlation for combustion inefficiency from alternative fuels [AIChE PAPER 79-0357] 21 p0158 A79-19687
- Regenerative burner system for thermoelectric power sources 22 p0261 A79-23621
- Proceedings of the Engineering Foundation Conference on Clean Combustion of Coal [PB-282949/7] 21 p0171 A79-10243
- Fluidized-bed combustion test of low-quality fuels: Texas lignite and lignite refuse [NERC/RI-78/3] 21 p0175 A79-10543
- Analytical evaluation of the impact of broad specification fuels on high bypass turbofan engine combustors [NASA-CR-159454] 21 p0200 A79-13050
- Evaluation of future jet fuel combustion characteristics [AD-A060218] 21 p0216 A79-14231
- Low-sulfur western coal use in existing small and intermediate size boilers --- particulate sampling and combustion efficiency [PB-287937/7] 22 p0346 A79-18061
- COMBUSTION PHYSICS**
- Oil recovery from a Utah tar sand deposit by in situ combustion 21 p0004 A79-10043
- Aspects of pulsating combustion --- gaseous methane burning system 21 p0008 A79-10072
- Combustion of porous particles --- coal for MHD generators 21 p0049 A79-12708
- A one-dimensional combustion model for a dual chamber stratified charge spark ignition engine [SAE PAPER 790355] 22 p0315 A79-31371
- The role of fundamental combustion in the future aviation fuels program --- carbon formation in gas turbine primary zones 21 p0202 A79-13195
- Characteristics and combustion of future hydrocarbon fuels 21 p0202 A79-13196
- Fundamental combustion studies of emulsified fuels for diesel applications [PB-287386/7] 22 p0330 A79-16138
- Combustion of hydrothermally treated coals [PB-287521/9] 22 p0338 A79-17025
- COMBUSTION PRODUCTS**
- New processes for the recovery of resource materials from coal combustion wastes 21 p0007 A79-10065
- Alternative fuels and combustion problems 21 p0051 A79-12978
- Future fuels in gas turbine engines 21 p0051 A79-12979
- Use of alternative fuels in stationary combustors 21 p0052 A79-12981
- Flame emissivities - Alternative fuels 21 p0052 A79-12984
- Kinetics of nitric oxide formation in combustion 21 p0053 A79-12989
- Emission control techniques for alternative fuel combustion 21 p0053 A79-12990
- Ash deposits and corrosion due to impurities in combustion gases; Proceedings of the International Conference, New England College, Henniker, N.H., June 26-July 1, 1977 21 p0080 A79-14926
- Corrosion of superalloys, inconels, and stainless steels by the products from fluidized-bed coal combustion 21 p0080 A79-14932
- Corrosion and deposits in MHD generator systems 21 p0081 A79-14935
- Coal-based electricity and air pollution control - A case for solvent refined coal 21 p0096 A79-15922
- Ionizing seed --- for open cycle MHD power generation 21 p0106 A79-16490
- The atmospheric CO2 consequences of heavy dependence on coal 21 p0107 A79-16524
- Reducing inefficiency and emissions of large steam generators in the United States 21 p0114 A79-17075
- The fate of trace elements in coal after combustion 21 p0116 A79-17250

## COMBUSTION STABILITY

## SUBJECT INDEX

- The measurement of the sulfuric acid and sulfate content of particulate matter resulting from the combustion of coal and oil 21 p0156 A79-19219
- Thermophoresis - Enhanced deposition rates in combustion turbine blade passages [ASME PAPER 78-WA/GT-1] 21 p0160 A79-19790
- Vaporization of drops of a melt of potassium carbonate in a medium of combustion products 21 p0167 A79-20411
- The electric conductivity of a plasma of combustion products of hydrocarbon fuels with alkali impurity 21 p0167 A79-20415
- Turbulence of a combustion product plasma in an MHD channel 22 p0246 A79-21538
- Emissions from pressurized fluidized-bed combustion processes 22 p0261 A79-23640
- Effects of fuel properties on soot formation in turbine combustion [SAE PAPER 781026] 22 p0274 A79-25899
- Toxic component concentration in kerosene-air mixture combustion products 22 p0291 A79-27733
- Conversion of biomass materials into gaseous products, phase 1 [SAN/1241-77/1] 21 p0171 N79-10237
- Low NOx combustion concepts for advanced power generation systems firing low-Btu gas [PB-282983/6] 21 p0178 N79-10610
- Ceramic technology readiness program [PE-2664-7] 21 p0180 N79-11223
- Elemental characteristics of aerosols emitted from a coal-fired heating plant [NASA-TM-78749] 21 p0191 N79-11560
- National Emissions Data System (NEDS) fuel use report (1974) [PB-284658/2] 21 p0194 N79-12251
- Antimony, arsenic, and mercury in the combustible fraction of municipal solid waste [PB-285196/2] 21 p0213 N79-13590
- Environmental effects of increased coal utilization ecological effects of gaseous emission from coal combustion [PB-285440/4] 21 p0213 N79-13591
- Performance characteristics of automotive engines in the United States. First series, report no. 16: 1975 121 CID (2.0 liters), F.I. [PB-286297/7] 21 p0227 N79-15311
- Analysis of radioactive contaminants in by-products from coal-fired power plant operations [PB-286365/2] 21 p0232 N79-15473
- Combustion research on the fate of fuel-nitrogen under conditions of pulverized coal combustion [PB-286208/4] 21 p0232 N79-15474
- COMBUSTION STABILITY**
- Aspects of pulsating combustion --- gaseous methane burning system 21 p0008 A79-10072
- Stability of combustion in the combustion chamber of an MHD generator 21 p0049 A79-12691
- COMMERCIAL AIRCRAFT**
- Advanced turbofan engines for low fuel consumption [ASME PAPER 78-GT-192] 21 p0033 A79-10816
- Technology for aircraft energy efficiency 21 p0066 A79-14136
- Alternate aircraft fuels prospects and operational implications 21 p0066 A79-14138
- Cryohydrogen-fuel for tomorrow's commercial aircraft 22 p0289 A79-27656
- Prospects for reducing the fuel consumption of civil aircraft 22 p0325 A79-31911
- Analytical evaluation of the impact of broad specification fuels on high bypass turbofan engine combustors [NASA-CR-159454] 21 p0200 N79-13050
- COMMERCIAL ENERGY**
- The application of photovoltaic roof shingles to residential and commercial buildings 21 p0020 A79-10170
- Predicting the performance of passive solar-heated buildings 21 p0063 A79-13899
- Commercial realization of MHD - A challenge for superconducting magnets 21 p0084 A79-15302
- Residential and commercial thermal storage --- for solar heating and cooling systems 21 p0090 A79-15865
- An overview of solar markets 21 p0092 A79-15884
- H-Coal pilot plant project and status of commercial development at Ashland --- coal gasification producing hydrogen and hydrocarbons 21 p0092 A79-15888
- Status and outlook of the Exxon Donor Solvent coal liquefaction process development 21 p0092 A79-15889
- Factors influencing solar energy commercialization 21 p0093 A79-15897
- Identification of cost effective energy conservation measures 21 p0099 A79-16133
- The Solar Heating and Cooling Commercial Demonstration Program at Marshall Space Flight Center - Some problems and conclusions 21 p0099 A79-16135
- Principles of solar cooling and heating 21 p0103 A79-16457
- Integrated solar building systems 21 p0103 A79-16460
- Application of solar cooling for a school building in subtropics 21 p0103 A79-16461
- Energy utilization analysis of buildings 21 p0103 A79-16462
- National program for the development of commercial MHD [AIAA PAPER 79-0188] 21 p0157 A79-19587
- Accelerating the commercialization on new technologies --- free market operation of federal alternate energy sources programs [ASME PAPER 78-WA/TS-4] 21 p0164 A79-19849
- Wind energy - The long road to commercialization 22 p0269 A79-24612
- Design study on solar energy systems for commercial buildings 22 p0320 A79-31433
- Civilian applications of laser fusion [UCRL-52349] 21 p0195 N79-12439
- Solar Heating And Cooling Of Buildings (SHACOB) commercialization report. Part A: Options and strategies. Volume 1: Executive summary [HCP/M70065-01/1] 21 p0207 N79-13512
- Solar Heating And Cooling Of Buildings (SHACOB) commercialization report. Part B: Analysis of market development, volume 2 [HCP/M70066-01/2] 21 p0207 N79-13513
- Energy use in Japan and the United States [BNL-23101] 21 p0221 N79-14578
- Venture analysis case study for on-site fuel cell energy systems [PCR-0783-VOL-1] 22 p0361 N79-20505
- COMMUNICATION SATELLITES**
- Proposals for power conditioning systems of high power communication satellites 21 p0033 A79-10897
- Enhanced power generation by optical solar reflectors on geostationary spinners 22 p0272 A79-25138
- Flywheel components for satellite applications [AD-A060586] 21 p0226 N79-15145
- COMMUNICATIONS TECHNOLOGY SATELLITE**
- Dynamics of stepping of the Hermes flexible solar array 22 p0323 A79-31615
- COMPATIBILITY**
- Behavior of nonmetallic materials in shale oil derived jet fuels and in high aromatic and high sulfur petroleum fuels --- compatibility of aircraft materials to fuels [AD-A060322] 21 p0226 N79-15203
- COMPENSATION**
- Optimality criteria in the compensation of the longitudinal boundary effect in induction MHD machines 22 p0298 A79-29277

# SUBJECT INDEX

# COMPUTER TECHNIQUES

## COMPONENT RELIABILITY

- Preliminary controller evaluation for the MERC/CTIU using a mathematical process model --- of Component Test and Integration Unit in fluidized bed combustion 21 p0008 A79-10073
- Reliability and durability of ceramic regenerators for gas turbine applications 21 p0050 A79-12823

## COMPOSITE MATERIALS

- Advanced composites - Future space applications 21 p0086 A79-15504
- Large filament wound structures for energy and transportation systems --- turbine blades for windpowered energy systems 21 p0086 A79-15507
- Flywheels for vehicles --- auxiliary power in electric automobiles 21 p0092 A79-15885
- Bibliographic and numeric data bases for fiber composites and matrix materials 21 p0114 A79-16984
- Selective application of materials for products and energy; Proceedings of the Twenty-third National Symposium and Exhibition, Anaheim, Calif., May 2-4, 1978 22 p0239 A79-20801
- Suitable optical materials for solar collector applications 22 p0239 A79-20823
- A composite-rim flywheel design 22 p0240 A79-20840
- Design, fabrication, and test of a composite material wind turbine rotor blade [NASA-CR-135389] 21 p0173 A79-10525
- Energy and Technology Review, June 1978 --- composite materials for flywheels, shale oil recovery, and seismic safety at nuclear power plants [UCRL-52000-78-6] 21 p0215 A79-14168
- COMPOSITE STRUCTURES
- Rotating strength of glass-carbon fiber-reinforced hybrid composite discs 21 p0165 A79-20273
- Composite material flywheel for the electric-powered passenger vehicle 22 p0240 A79-20842
- A status of the 'Alpha-ply' composite flywheel concept development 22 p0241 A79-20843
- Flywheel energy accumulators for road vehicles 22 p0241 A79-20845
- Composite material flywheels for energy storage on electricity supply systems 22 p0241 A79-20852
- Current status of composite flywheel development 22 p0241 A79-20853

## COMPOSITION (PROPERTY)

- The influence of fuel composition on smoke emission from gas-turbine-type combustors - Effect of combustor design and operating conditions 22 p0323 A79-31510

## COMPRESSED AIR

- Ejector augmentation of the air supply in a compressed air energy storage plant 21 p0013 A79-10109
- Modeling the champagne effect in compressed air energy storage 22 p0280 A79-26190
- Performance of a hydraulic air compressor for use in Compressed Air Energy Storage power systems 22 p0280 A79-26191

## COMPRESSED GAS

- High efficiency wave engine --- featuring rotor blade exit nozzle design for high efficiency 22 p0279 A79-26187

## COMPRESSING

- Experiments on adiabatic compression of a tokamak plasma in Foman-2 21 p0069 A79-14457

## COMPRESSOR EFFICIENCY

- Modeling the champagne effect in compressed air energy storage 22 p0280 A79-26190
- Performance of a hydraulic air compressor for use in Compressed Air Energy Storage power systems 22 p0280 A79-26191

## COMPRESSORS

- The matching of a free piston Stirling engine coupled with a free piston linear compressor for a heat pump application 21 p0028 A79-10204
- Some applications of LaNi5-type hydrides --- using reversible reaction with hydrogen working fluid for heat storage 22 p0249 A79-21694

## COMPUTATION

- Calculation of backup requirements 21 p0218 A79-14533

## COMPUTER NETWORKS

- A computerized reporting and monitoring system for geothermal energy development [LBL-8483] 22 p0369 A79-21555

## COMPUTER PROGRAMS

- SINWEST - A simulation model for wind energy storage systems 21 p0029 A79-10241
- Investigation of the optimal use of geothermal waters for the heating of several types of dwelling in various European climates 21 p0075 A79-14739
- The use and limitations of ASHRAE solar algorithms in solar energy utilization studies 21 p0101 A79-16416
- Analysis and design of solar buildings using the Cal-ERDA computer programs 21 p0137 A79-17463
- WATSUN - A simulation program for solar-assisted heating systems 22 p0321 A79-31439
- Vehicle Design Evaluation Program (VDEP). A computer program for weight sizing, economic, performance and mission analysis of fuel-conservative aircraft, multibodied aircraft and large cargo aircraft using both JP and alternative fuels [NASA-CR-145070] 21 p0200 A79-13026
- Verification methodology for the DOE-1 building energy analysis computer program [LA-UR-78-1493] 21 p0208 A79-13520
- Integrated safeguards information System (ISIS), executive summary --- nuclear power plant and fissionable materials security [PB-286869/3] 21 p0223 A79-14934
- Life-cycle costing. A guide for selecting energy conservation projects for public buildings --- computing the cost effectiveness of retrofitting and new buildings [PB-287804/9] 22 p0345 A79-17744
- Evaluation of MOSTAS computer code for predicting dynamic loads in two bladed wind turbines [NASA-TN-79101] 22 p0368 A79-21549
- COMPUTER SYSTEMS DESIGN
- A microprocessor based solar monitoring system 21 p0088 A79-15838
- A microprocessor-based control system for solar heating and cooling 21 p0107 A79-16565
- Solar Total Energy Control Data Acquisition System 21 p0144 A79-17618

## COMPUTER SYSTEMS PROGRAMS

- Computer modeling of automotive engine combustion [UCRL-80451] 21 p0181 A79-11412

## COMPUTER TECHNIQUES

- Effects of weather and pollution on incident solar energy - Basic measurements leading to computer models 21 p0065 A79-14117
- Improvement of direct-current electrical prospecting methods for the geothermal investigation of the Rhine Graben 21 p0075 A79-14734
- National Computer Conference, Anaheim, Calif., June 5-8, 1978, Proceedings 21 p0100 A79-16177
- Floating dry cooling, a competitive alternative to evaporative cooling in a binary cycle geothermal power plant [ASME PAPER 78-WA/ENER-2] 21 p0159 A79-19775
- Computer based sun following system 22 p0242 A79-21165
- The application of hydraulics in the 2,000 kW wind turbine generator 22 p0288 A79-27400

## COMPUTERIZED DESIGN

Theoretical and computational analysis of MHD machines with two-layer windings and half-filled slots and the inductor edges

22 p0298 A79-29286

## COMPUTERIZED DESIGN

Airfoil data for use of wind turbine designers

21 p0073 A79-14702

Capital cost system optimization of OTEC power modules

21 p0101 A79-16249

Anticonvective antiradiative systems --- for solar collectors

21 p0132 A79-17420

Optimization of a diagonal MHD channel

22 p0247 A79-21628

Digital or analog modelling in the design of hydrostatic vehicular systems

22 p0264 A79-23808

Optimization of a novel hydrostatic drive performance using hybrid computing technique --- for automobile engines

22 p0264 A79-23809

Two-dimensional MHD channel design --- for energy performance improvement at lower wall temperature

22 p0279 A79-26183

WATSUN - A simulation program for solar-assisted heating systems

22 p0321 A79-31439

Parametric study of two planar high power flexible solar array concepts [NASA-CR-157841]

21 p0205 A79-13501

## COMPUTERIZED SIMULATION

Computer aided optimization of integrated coal gasification combined cycle power plants

21 p0008 A79-10075

Economic optimization of the coal-fired MHD Steam Power Plant

21 p0016 A79-10134

Reducing combustion air temperature variations in magnetohydrodynamic/steam power plants

21 p0016 A79-10135

Simulation of solar powered Rankine cycle systems

21 p0022 A79-10179

A computer and experimental simulation of Stirling cycle machines

21 p0023 A79-10192

SIMWEST - A simulation model for wind energy storage systems

21 p0029 A79-10241

The laser fusion scientific feasibility experiment

21 p0030 A79-10250

Magnetohydrodynamic/steam power plant modeling and control

21 p0046 A79-12274

Simulations of the performance of open cycle desiccant systems using solar energy

21 p0066 A79-14262

Estimating hourly solar radiation for one-axis tracking focusing collectors

21 p0071 A79-14678

A microprocessor based solar controller

21 p0082 A79-14979

Passive solar heating of buildings [LA-UR-77-1162]

21 p0090 A79-15859

Performance of vacuum tube solar collector systems

21 p0102 A79-16424

The El Camino Real Solar Cooling Demonstration Project

21 p0102 A79-16425

Energy utilization analysis of buildings

21 p0103 A79-16462

Temperature dependent parameter analysis of thermoelectric devices

21 p0113 A79-16740

On the use of eddy-current couplings in wind-driven synchronous machines

21 p0113 A79-16742

Efficient use of wind energy by using static slip recovery systems - A simulator study

21 p0113 A79-16744

The relationship between diffuse and total solar radiation in computer simulation of solar energy systems

21 p0119 A79-17304

A simulation study of phase change energy store

21 p0120 A79-17318

Phase change thermal storage for a solar total energy system

21 p0120 A79-17321

## SUBJECT INDEX

Simulation and cost of photovoltaic generators

21 p0122 A79-17334

Computer simulation of the performance of a solar pond in the southern part of Iran

21 p0133 A79-17432

Comparison between simulation and experiment of solar heating

21 p0137 A79-17461

Simulation and design of evacuated tubular solar residential air conditioning systems and comparison with actual performance

21 p0138 A79-17475

Solar heating for a novel dwelling independent of servicing networks

21 p0140 A79-17492

Gasification Combined Cycle Test Facility at Pekin, Illinois

21 p0145 A79-17632

Optimal control of on-board and station flywheel storage for rail transit systems

21 p0148 A79-17822

Energy requirements of the rail mode [ASME PAPER 78-RT-1]

21 p0150 A79-18085

Modeling energy and power requirements of electric vehicles

21 p0153 A79-18465

Energy effectiveness of arbitrary arrays of wind turbines

21 p0156 A79-19540

Gas stream composition and temperature determination in a coal-fired MHD simulation facility [ASME PAPER 78-WA/HT-23]

21 p0161 A79-19810

Solar collector storage panel [ASME PAPER 78-WA/SOL-12]

21 p0163 A79-19844

Augmented solar energy collection using different types of planar reflective surfaces - Theoretical calculations and experimental results

22 p0242 A79-21166

Dynamic simulation studies of fuel conservation procedures used in terminal areas

22 p0259 A79-23581

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22 p0263 A79-23776

System performance predictions for solar cooling using regional stochastic weather models

22 p0264 A79-23781

Solar system modeling using a modular approach with generalized programs for working fluid properties

22 p0266 A79-24310

A computer simulation model for determining preferred solar heating and cooling systems

22 p0267 A79-24313

Flow modeling of an atmospheric pressure, entrained-type coal gasifier

22 p0280 A79-26188

Performance of combined solar-heat pump systems

22 p0285 A79-26817

An investigation of dark current and photocurrent superposition in photovoltaic devices

22 p0291 A79-27871

A general design method for closed-loop solar energy systems

22 p0295 A79-28359

Evaluation of MOSTAS computer code for predicting dynamic loads in two-bladed wind turbines

22 p0298 A79-29007

Efficiency studies about Daihatsu engine/electric hybrid system [SAE PAPER 790013]

22 p0314 A79-31352

Component-based simulator for solar systems [LA-UR-78-1494]

21 p0208 A79-13521

The updated algorithm of the Energy Consumption Program (ECP): A computer model simulating heating and cooling energy loads in buildings

22 p0351 A79-19059

Simulation of fluidized bed coal combustors [NASA-CR-159529]

22 p0359 A79-20487

Insulating wall boundary layer in a Faraday MHD generator [PB-23417]

22 p0365 A79-21310

# SUBJECT INDEX

# CONCENTRATORS

## CONCENTRATORS

- Design, construction, and testing of a Fixed Mirror Solar Concentrator field 21 p0020 A79-10164
- Measurement of heat loss from a heat receiver assembly of a Fixed Mirror Solar Concentrator 21 p0020 A79-10166
- Photovoltaic concentrating array 21 p0021 A79-10172
- A vacuum solar thermal collector with optimal concentration 21 p0043 A79-11970
- Optical evaluation techniques for reflecting solar concentrators 21 p0043 A79-11971
- Nonimaging solar concentrators 21 p0043 A79-11973
- Comparison of the solar concentrating properties of truncated hexagonal, pyramidal and circular cones 21 p0043 A79-11974
- Molten-carbonate CO2 concentrator - Preliminary experiments [ASME PAPER 78-ENAS-2] 21 p0048 A79-12551
- General principles of multielement concentrating system design --- solar collectors 21 p0054 A79-13291
- Facility with sectioned photoreceiver and laser radiator for determining solar radiation concentrator accuracy characteristics 21 p0054 A79-13292
- Solar power plants in the U.S.A. 21 p0057 A79-13640
- Development of solar thermal power plants 21 p0057 A79-13641
- Experimental results and concepts of different solar concentrators 21 p0057 A79-13643
- Solar thermal power stations 21 p0057 A79-13644
- Design of a second generation concentrating tracking solar collector [AIAA PAPER 78-1775] 21 p0062 A79-13872
- Performance of evacuated solar collectors with compound parabolic concentrators 21 p0089 A79-15855
- Verification of wedge concentration using a helium neon laser --- solar collector design 21 p0098 A79-16104
- Analysis of optical behavior and collector performance of a solar concentrator 21 p0107 A79-16545
- Concentrator photovoltaic systems for economical electricity and heat 21 p0124 A79-17354
- On the design of CPC photovoltaic solar collectors --- Compound Parabolic Concentrator 21 p0124 A79-17355
- Transcell, a novel approach for improving static photovoltaic concentration 21 p0124 A79-17356
- Response of a solar cell to intense and nonuniform illumination when used with solar concentrators 21 p0125 A79-17357
- Performance of optimal geometry three step compound wedge stationary concentrator --- solar collector using flat side mirrors 21 p0134 A79-17438
- A compound parabolic concentrator for a high temperature solar collector requiring only twelve tilt adjustments per year 21 p0134 A79-17439
- Compound parabolic concentrators with non-evacuated receivers - Prototype performance and a larger scale demonstration in a school heating system 21 p0134 A79-17440
- Development of solar collectors for low temperature level and of concentrators for thermal and photoelectric conversion 21 p0135 A79-17445
- High temperature solar collector of optimal concentration - Non-focusing lens with secondary concentrator 21 p0135 A79-17448
- The USA 5MW solar thermal test facility 21 p0135 A79-17449
- Distribution of beam radiation of the receiver plane of a CPC solar concentrator --- Compound Parabolic Concentrators 21 p0135 A79-17451
- Large-aperture radiant solar energy concentrators 21 p0135 A79-17452
- Performance of solar concentrators - A theoretical study 21 p0135 A79-17453
- Solar concentrators --- using cheap refractive lenses 21 p0136 A79-17455
- A simple solar tracking system --- manually adjusted rotating shaft for solar concentrator positioning 21 p0136 A79-17457
- Manufacture of curved glass mirrors for linear concentrators 21 p0136 A79-17459
- Design of solar energy concentrators for power generation in residential and nonresidential areas 21 p0136 A79-17460
- A reflector concentrator modified sterling engine unit and an aqua-ammonia absorber gas turbine unit for farm power needs 21 p0142 A79-17509
- The development of photovoltaic conversion systems with sunlight concentration 21 p0148 A79-17995
- Econometric analysis of concentrators for solar cells 21 p0149 A79-18017
- Ideal prism solar concentrators 21 p0149 A79-18023
- The place of extreme asymmetrical non-focussing concentrators in solar energy utilization 21 p0149 A79-18024
- A cavity receiver design for solar heated gas turbine generating systems [ONEHA, TP NO. 1978-137] 21 p0155 A79-18560
- Solar receiver performance of point focusing collector system [ASME PAPER 78-WA/SOL-5] 21 p0163 A79-19838
- Thermal deformations of solar-energy concentrators 21 p0166 A79-20355
- A comparison of compound parabolic and simple parabolic concentrating solar collectors 22 p0262 A79-23754
- Flux-redistribution in the focal region of a planar Fresnel ring mirror --- solar furnace design 22 p0263 A79-23764
- Series resistance effects in /GaAl/As/GaAs concentrator solar cells 22 p0273 A79-25745
- Efficient Fresnel lens for solar concentration 22 p0285 A79-26816
- Effect of form errors on the characteristics of ellipsoidal radiant energy concentrators 22 p0296 A79-28667
- Symmetrical and asymmetrical ideal cylindrical radiation transformers and concentrators 22 p0303 A79-29647
- Photovoltaic concentrator system technology and applications experiments [ASME PAPER 79-SOL-9] 22 p0308 A79-30544
- Thermal performance evaluation of a flat-plate cylindrical parabolic concentrator and a flat-plate collector 22 p0317 A79-31408
- Design package for concentrating solar collector panels [NASA-CR-150788] 21 p0173 A79-10523
- Status of the DOE photovoltaic concentrator technology development project [SAND-78-0948C] 21 p0176 A79-10550
- Thermal analysis of receivers for solar concentrators and optimization procedure for power production 21 p0182 A79-11465
- Non-tracking solar energy collector system [NASA-CASE-NPO-13817-1] 21 p0182 A79-11471
- Fixed mirror solar concentrator for power generation [GA-A-14883] 21 p0187 A79-11526
- Concentrating solar collector test results, Collector Module Test Facility [SAND-78-0815] 21 p0208 A79-13522

# CONCENTRIC CYLINDERS

# SUBJECT INDEX

Performance characteristics of a 1.8 by 3.7 meter  
Fresnel lens solar concentrator  
[NASA-TN-78222] 22 p0360 A79-20495

## CONCENTRIC CYLINDERS

Optimum design parameters of horizontal coaxial  
cylinders for a solar energy collector  
21 p0134 A79-17444

## CONCORDE AIRCRAFT

Powerplant integration - The application of  
current experience to future developments  
[ASME PAPER 78-GT-113] 21 p0032 A79-10788

## CONCRETES

Periodic heating/cooling by solar radiation ---  
through concrete slab buildings  
21 p0140 A79-17491

## CONDENSERS

History and development of condensers at the  
Geysers geothermal power plant  
[ASME PAPER 78-JPGC-PWR-18] 21 p0150 A79-18099  
Selection of thermal operating regimes for fuel  
cell reactor-condenser systems  
21 p0165 A79-20342

## CONDENSERS (LIQUIFIERS)

Heat exchangers for Ocean Thermal Energy  
Conversion plants  
21 p0142 A79-17506

## CONDUCTING FLUIDS

On the diffusive instability of some simple steady  
magnetohydrodynamic flows  
22 p0278 A79-26163

## CONDUCTIVE HEAT TRANSFER

Heat transfer in phosphoric acid fuel cell stacks  
21 p0010 A79-10091  
Thermal calculations for the reactor of a  
solar-power unit to produce hydrogen by  
thermolysis of water  
21 p0167 A79-20360  
Optimal distribution of heat conducting material  
in the finned pipe solar energy collector  
22 p0242 A79-21163  
Estimating heat loads on multistage thermoelectric  
heat pumps  
22 p0260 A79-23614  
Earth-conducted heat losses from thermal storage  
systems  
22 p0281 A79-26208

## CONDUCTORS

Conductor for LASL 10-MW/hr superconducting energy  
storage coil  
21 p0085 A79-15309

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21 p0044 A79-12037  
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21 p0047 A79-12376  
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21 p0051 A79-12977  
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21 p0055 A79-13619  
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21 p0063 A79-14106

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21 p0076 A79-14760

Tokamak reactors for breakeven: A critical study  
of the near-term fusion reactor  
program --- Book  
21 p0077 A79-14776

Ash deposits and corrosion due to impurities in  
combustion gases; Proceedings of the  
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21 p0080 A79-14926

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Air-Conditioning Engineers, Annual Meeting,  
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## SUBJECT INDEX

## CONGRESSIONAL REPORTS

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- Applied Superconductivity Conference, Pittsburgh,  
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- Selective application of materials for products  
and energy; Proceedings of the Twenty-third  
National Symposium and Exhibition, Anaheim,  
Calif., May 2-4, 1978  
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Supplement  
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University of Pittsburgh, Pittsburgh, Pa., April  
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modeling - Ecological and biomedical modeling.  
Part 2 - Socioeconomic modeling. Part 3 -  
Control and identification. Part 4 Methodology  
and applications  
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December 10-15, 1978  
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[NATO/CCMS-85] 22 p0275 A79-25926
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Proceedings of the Winter Annual Meeting, San  
Francisco, Calif., December 10-15, 1978  
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- Thermal storage and heat transfer in solar energy  
systems; Proceedings of the Winter Annual  
Meeting, San Francisco, Calif., December 10-15,  
1978  
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- Oceans '78: The ocean challenge; Proceedings of  
the Fourth Annual Combined Conference,  
Washington, D.C., September 6-8, 1978  
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- Applications of cryogenic technology. Volume 7 -  
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Energy Systems, Oak Brook, Ill., May 16-18, 1978  
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Annual Conference, University of Western  
Ontario, London, Canada, August 20-24, 1978.  
Volumes 1 & 2  
22 p0316 A79-31401
- Energy and aerospace; Proceedings of the  
Anglo-American Conference, London, England,  
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- Metallurgical coatings 1978; Proceedings of the  
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Calif., April 3-7, 1978. Volumes 1 & 2  
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[NASA-CP-2058] 21 p0169 A79-10122
- Proceedings of the Engineering Foundation  
Conference on Clean Combustion of Coal  
[PB-282949/7] 21 p0171 A79-10243
- Improved Conversion Efficiency Workshop. Volume 2:  
Summary  
[CONP-771003-P2-VOL-2] 21 p0176 A79-10551
- Multidisciplinary research related to the  
atmospheric sciences  
[PB-283076/8] 21 p0179 A79-10679
- Committee on the challenges of modern society  
rational use of energy pilot study modular  
integrated utility system project. Volume 2:  
Minutes of project meeting  
[PB-283429/9] 21 p0191 A79-11558
- The energy dilemma: A challenge for Maryland.  
Proceedings Maryland General Assembly/AISLE  
Conference  
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- Naval Air Systems Command-Naval Research  
Laboratory Workshop on Basic Research Needs for  
Synthetic Hydrocarbon Jet Aircraft Fuels  
[AD-A060081] 21 p0216 A79-14235
- Technology and Use of Lignite --- conferences  
[GPERC/IC-77/1] 21 p0216 A79-14241
- Proceedings of Energy Resource 5th Conference  
[PB-286246/4] 21 p0230 A79-15423
- The rotary combustion engine: A candidate for  
general aviation --- conferences  
[NASA-CP-2067] 22 p0329 A79-15961
- Alternative hydrocarbon fuels: Combustion and  
chemical kinetics --- synthetic aircraft fuels  
[AD-A061050] 22 p0338 A79-17011
- Proceedings of symposium on water-in-fuel  
emulsions in combustion --- marine diesels,  
boilers, and gas turbine engines  
[AD-A061503] 22 p0338 A79-17019
- Symposium on Energy Today and Tomorrow  
[CSIR-S-145] 22 p0340 A79-17316
- EPA program conference report: Coal cleaning, an  
option for Increased Coal Utilization  
[PB-288223/1] 22 p0344 A79-17378
- Energy environment III  
[EPA-600/9-78-022] 22 p0346 A79-18352
- Public hearing transcript: Federal non-nuclear  
energy research and development program  
[PB-287910/4] 22 p0349 A79-18464
- Energy/environment 1978: Symposium on energy  
development impacts  
[PB-288578/8] 22 p0355 A79-19470
- Geothermal resources for aquaculture  
[PB-290345/8] 22 p0356 A79-19563
- The 1977 Goddard Space Flight Center Battery  
Workshop  
[NASA-CP-2041] 22 p0370 A79-21565
- Report of the 4th CCMS (Committee on the  
Challenges of Modern Society) Solar Energy Pilot  
Study Meeting  
[PB-289492/1] 22 p0372 A79-21631
- CONGRESSIONAL REPORTS
- National Aeronautics and Space Act of 1958, as  
amended, and related legislation  
[GPO-34-175] 21 p0214 A79-13932
- Energy information: Report to Congress  
[NTISUB/C/027-001] 21 p0221 A79-14576
- Symposium on the Future of Space Science and Space  
Applications  
[GPO-23-876] 21 p0224 A79-15105
- The national energy plan: Options under  
assumptions of national security threat ---  
economic impact procurement policy, and  
resources management  
[H-PRINT-95-48] 21 p0228 A79-15398
- US energy demand and supply, 1976-1985: Limited  
options, unlimited constraints  
[H-PRINT-95-43] 21 p0228 A79-15400
- United States civilian space programs: An overview  
[GPO-35-823] 21 p0232 A79-15815
- Energy and the economy: The economic impact of  
alternative energy supply-demand assumptions  
[H-PRINT-95-51] 22 p0333 A79-16352
- Industrial energy conservation  
[GPO-24-067] 22 p0333 A79-16353
- Research and development needs to merge  
environmental and energy objectives  
[GPO-23-254] 22 p0342 A79-17339
- Electric and Hybrid Vehicle Act, Public Law 94-413  
demonstration program objective and schedule  
[GPO-98-809] 22 p0351 A79-18810

## CONNECTICUT

## SUBJECT INDEX

Authorizing appropriations to the National  
Aeronautics and Space Administration  
[H-REPT-96-52] 22 p0364 N79-20928

## CONNECTICUT

A commentary on a methodology for assessment of  
the environmental impact of the electrical power  
system within the Connecticut River Basin  
21 p0093 A79-15893

## CONSTRUCTION

Principles of design and construction for marine  
structures for wave/tidal/ocean thermal energy  
21 p0152 A79-18114

Satellite Power Systems (SPS) concept definition  
study (exhibit C) 21 p0183 N79-11475  
[NASA-CR-150827]

## CONSTRUCTION MATERIALS

Materials problems and opportunities in coal  
conversion systems 21 p0034 A79-11146

Materials problems and possible solutions for near  
term tokamak fusion reactors 21 p0079 A79-14790

Materials problems and opportunities in coal  
conversion systems 21 p0094 A79-15900

Materials problems in solar, nuclear and storage  
of energy 21 p0094 A79-15901

Materials and economics of energy  
systems 21 p0095 A79-15911

Selective application of materials for products  
and energy; Proceedings of the Twenty-third  
National Symposium and Exhibition, Anaheim,  
Calif., May 2-4, 1978 22 p0239 A79-20801

Encapsulant materials for \$2/watt terrestrial  
photovoltaic arrays 22 p0266 A79-24138

## CONTACT POTENTIALS

Development of economical improved thick film  
solar cell contact  
[NASA-CR-150835] 22 p0359 N79-20486

## CONTACT RESISTANCE

High reliability contacts for miniature  
thermoelectric converters 21 p0027 A79-10228

Determination of thermal contact resistances ---  
for solar thermoelectric generators 21 p0166 A79-20351

## CONTAMINANTS

Source emissions factors for refuse derived fuels  
21 p0082 A79-15084

## CONTINENTAL SHELVES

ERDA'S oceanographic program for the mid-Atlantic  
coastal region --- impact of offshore energy  
development on coastal ecology 21 p0192 N79-11641

Environmental assessment of the Alaskan  
Continental Shelf. Volume 1: Biological studies  
[PB-289154/7] 22 p0344 N79-17366

Environmental assessment of the Alaskan  
Continental Shelf. Volume 2: Biological studies  
[PB-289155/4] 22 p0344 N79-17367

Environmental assessment of the Alaskan  
Continental Shelf. Volume 3: Biological studies  
[PB-289156/2] 22 p0344 N79-17368

Marine biological effects of OCS petroleum  
development 22 p0344 N79-17374

[PB-288935/0]

## CONTINENTS

Heat flow and radiogenic heat production in Brazil  
with implications for thermal evolution of  
continents 22 p0373 N79-21689

## CONTROL

Regulation and control concepts for the  
possibilities of a utilization of solar energy  
in the low-temperature range 22 p0305 A79-30345

Power management and control for space systems  
21 p0170 N79-10134

## CONTROL CONFIGURED VEHICLES

Fuel conservative subsonic transport --- control  
surfaces activated by computers 22 p0337 N79-16874

## CONTROL EQUIPMENT

Preliminary controller evaluation for the  
MPEC/CIU using a mathematical process model ---  
of Component Test and Integration Unit in  
fluidized bed combustion 21 p0008 A79-10073

Design and operating experience on the U.S.  
Department of Energy Experimental Mod-C 100 kW  
Wind Turbine 21 p0028 A79-10234

Electronic components in solar technology  
21 p0056 A79-13629

Control of solar energy systems, heat storage, and  
heat utilization 21 p0056 A79-13630

Simple high-accuracy diode temperature-difference  
control circuit 21 p0056 A79-13631

Considerations in choosing solar energy monitoring  
systems 21 p0087 A79-15831

Controls for residential solar heating  
21 p0101 A79-16418

Solar controls and control modifications - New  
century town solar homes, Vernon Hills, IL.  
21 p0102 A79-16419

Control strategy for a variable-speed wind energy  
conversion system 22 p0303 A79-29800

Control system for solar hot water system  
22 p0321 A79-31442

Measurement and control techniques in geothermal  
power plants  
[TREE-1312] 22 p0362 N79-20508

## CONTROL SIMULATION

Simulation study of the effect of  
fuel-conservative approaches on ATC procedures  
and terminal area capacity 21 p0031 A79-10398

[SAE PAPER 780523]  
A microprocessor based solar controller 21 p0082 A79-14979

Control of wind turbine generators connected to  
power systems 21 p0086 A79-15574

Efficient use of wind energy by using static slip  
recovery systems - A simulator study 21 p0113 A79-16744

Study of integrated gasification combined cycle  
plant interaction and control  
[ASME PAPER 79-GT-60] 22 p0306 A79-30530

## CONTROL SURFACES

Fuel conservative subsonic transport --- control  
surfaces activated by computers 22 p0337 N79-16874

## CONTROL THEORY

Dynamic model of an industrial plant manufacturing  
a variety of products 21 p0051 A79-12957

Conference on Decision and Control, and Symposium  
on Adaptive Processes, 16th, and Special  
Symposium on Fuzzy Set Theory and Applications,  
New Orleans, La., December 7-9, 1977,  
Proceedings. Volumes 1 & 2 21 p0081 A79-14957

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the Ninth Annual Pittsburgh Conference,  
University of Pittsburgh, Pittsburgh, Pa., April  
27, 28, 1978. Part 1 - Energy and power system  
modeling - Ecological and biomedical modeling.  
Part 2 - Socioeconomic modeling. Part 3 -  
Control and identification. Part 4 Methodology  
and applications 22 p0263 A79-23776

CONFERENCE ON DECISION AND CONTROL, AND SYMPOSIUM  
ON ADAPTIVE PROCESSES, 16TH, AND SPECIAL  
SYMPOSIUM ON FUZZY SET THEORY AND APPLICATIONS,  
NEW ORLEANS, LA., DECEMBER 7-9, 1977,  
PROCEEDINGS. VOLUMES 1 & 2

Modeling and simulation. Volume 9 - Proceedings of  
the Ninth Annual Pittsburgh Conference,  
University of Pittsburgh, Pittsburgh, Pa., April  
27, 28, 1978. Part 1 - Energy and power system  
modeling - Ecological and biomedical modeling.  
Part 2 - Socioeconomic modeling. Part 3 -  
Control and identification. Part 4 Methodology  
and applications 22 p0263 A79-23776

## CONTROLLABILITY

Modelling and control of a fluidized bed gasifier  
22 p0332 N79-16345

## CONTROLLED FUSION

Fusion-Fission Energy Systems 21 p0017 A79-10144

Doublet III design and construction --- Tokamak  
fusion research device 21 p0018 A79-10145

Demonstration and commercial prototype tokamak  
reactors 21 p0018 A79-10146

The Mirror Fusion Test Facility /MFTF/  
21 p0018 A79-10147

Mirror fusion reactors 21 p0018 A79-10148



# SUBJECT INDEX

# COOLING SYSTEMS

Overview of inertial confinement fusion reactor designs 21 p0018 A79-10149

Compact fusion reactors using controlled imploding liners 21 p0018 A79-10151

The fast power cycle for fusion reactors 21 p0018 A79-10152

Hybrid reactor based on laser-induced thermonuclear fusion 21 p0032 A79-10658

Fusion power with particle beams 21 p0034 A79-11121

Development of energetic neutral beams to the megawatt power level for controlled thermonuclear research 21 p0054 A79-13439

Heavy-ion beam inertial-confinement fusion 21 p0054 A79-13448

Ohmic heating experiments in the L-2 stellarator 21 p0070 A79-14460

The mirror machine program in the USA --- controlled fusion experiments and research facilities 21 p0070 A79-14461

Generation and applications of high power ion beams to fusion research 21 p0070 A79-14466

Fusion reactor problems --- plasma confinement and interface engineering 21 p0071 A79-14468

Philosophy and physics of predemonstration fusion devices 21 p0078 A79-14783

Predemonstration fusion devices - Research and development needs 21 p0078 A79-14785

Superconducting magnets - Some fundamentals and their state of the art 21 p0079 A79-14788

Fusion power by magnetic confinement - Program plan 21 p0080 A79-14794

Large-scale cryopumping for controlled fusion 21 p0085 A79-15330

Materials and economics of energy systems 21 p0095 A79-15911

Dynamics and feedback control of ISX tokamak 21 p0107 A79-16559

Superconductivity for mirror fusion 22 p0236 A79-20542

Optimum properties of a noncylindrical pinch --- neutron energy yield in fusion plasma 22 p0244 A79-21433

The synergetics of the catalytic D-D-fusion-fission breeder 22 p0252 A79-22236

Minimum-average-B wells in linked magnetic mirror fields --- for plasma control in fusion reactors 22 p0252 A79-22237

Particle orbits in field-reversed mirrors --- for plasma confinement in fusion reactor 22 p0253 A79-22239

Applications of cryogenic technology. Volume 7 - Proceedings of the Conference on Cryogenic Energy Systems, Oak Brook, Ill., May 16-18, 1978 22 p0289 A79-27651

Doublet III --- tokamak program review 22 p0290 A79-27667

The Alcator liquid nitrogen-cooled tokamaks 22 p0290 A79-27668

Status report on TFTR --- Toroidal Fusion Test Reactor 22 p0290 A79-27669

Cryogenic technology and superconductivity in controlled fusion 22 p0311 A79-31003

MHD stability of Spheromak 22 p0313 A79-31189

Large tokamak experiments - Report on the Third IAEA Technical Committee Meeting, Paris, 1-6 September 1978 22 p0313 A79-31193

The JET project - A step towards the production of power by nuclear fusion 22 p0326 A79-31918

Overview of the magnetic fusion energy development and technology program [HCP/T3073-01] 21 p0193 W79-11887

## CONTROLLERS

A Thermic Controller for a thermic diode solar panel [ASME PAPER 78-WA/SOL-9] 21 p0163 A79-19841

A multivariable controller for an automotive gas turbine [ASME PAPER 79-GT-73] 22 p0307 A79-30537

Design package for programmable controller and hydronic subsystem [NASA-CR-161151] 22 p0371 W79-21619

## CONVECTION

Conditions for absolute stability of salt gradient solar ponds 21 p0133 A79-17431

## CONVECTIVE HEAT TRANSFER

Rate of desorption in a solar regenerator 21 p0055 A79-13611

A simulation study of phase change energy store 21 p0120 A79-17318

A passive rock bed - Design, construction, and performance 21 p0121 A79-17328

Convective effects in 'slat collectors' 21 p0129 A79-17400

Simulation study of natural convection heat transfer in inclined air layers with application to solar energy collection 21 p0129 A79-17401

Recent advances in convectively cooled engine and airframe structures for hypersonic flight 21 p0165 A79-20087

The cryogenic heat transfer tunnel - A new tool for convective research --- thermal efficiency testing of solar tower receiver 22 p0267 A79-24316

Natural convection heat transfer in small and moderate aspect ratio enclosures - An application to flat plate collectors 22 p0281 A79-26206

Dimensional relations for free convective heat transfer in flat-plate collectors --- solar collector heat loss 22 p0316 A79-31406

Methods for reducing heat losses from flat plate solar collectors, phase 2 [COO-2597-4] 21 p0188 W79-11533

## CONVERTERS

Thermal converters with transverse thermoelectromotive forces 22 p0256 A79-22847

## COOLING

Estimating heat loads on multistage thermoelectric heat pumps 22 p0260 A79-23614

An assessment of thermal energy storage and waste heat dissipation with total energy systems for MIT [AD-A059061] 21 p0205 W79-13502

Prototype solar heating and cooling systems including potable hot water [NASA-CR-150861] 22 p0334 W79-16372

Geographical variation in the heating and cooling requirements of a typical single-family house, and correlation of these requirements to degree days [PB-289204/0] 22 p0355 W79-19467

## COOLING SYSTEMS

Advanced industrial gas turbine cooling and high pressure compressor technology 21 p0004 A79-10041

Performance of a Stirling engine powered heat activated heat pump --- gas heating-cooling system 21 p0011 A79-10098

Cooling radioisotope thermoelectric generators in the Shuttle 21 p0023 A79-10186

Melting multifoil insulation for KIPS emergency cooling --- Kilowatt Isotope Power System 21 p0023 A79-10191

A solar energy system for space heating and space cooling --- retrofitting aged buildings 21 p0072 A79-14686

Barriers and incentives to the commercialization of solar heating and cooling of buildings 21 p0072 A79-14687

Economic optimization of heatpump assisted solar heating in Illinois 21 p0072 A79-14691

Development of cryogenic targets for laser fusion 21 p0085 A79-15333

- Point-contact conduction-cooling technique and apparatus for cryogenic laser fusion pellets  
21 p0085 A79-15335
- Conference on Performance Monitoring Techniques for Evaluation of Solar Heating and Cooling Systems, Washington, D.C., April 3, 4, 1978, Proceedings  
21 p0087 A79-15826
- Application of solar cooling for a school building in subtropics  
21 p0103 A79-16461
- Stochastic simulation experiments on solar air conditioning systems  
21 p0138 A79-17474
- Simulation and design of evacuated tubular solar residential air conditioning systems and comparison with actual performance  
21 p0138 A79-17475
- Theoretical basis and design for a residential size solar powered ammonia/water absorption air conditioning system  
21 p0139 A79-17479
- An experimental evaluation of an intermittent cycle solar-powered ammonia/water absorption air conditioning system  
21 p0139 A79-17481
- Integration of evacuated tubular solar collectors with lithium bromide absorption cooling systems  
21 p0139 A79-17483
- Solar heated and cooled financial building  
21 p0139 A79-17484
- Floating dry cooling, a competitive alternative to evaporative cooling in a binary cycle geothermal power plant  
[ASME PAPER 78-WA/ENER-2] 21 p0159 A79-19775
- Design of a freon jet pump for use in a solar cooling system  
[ASME PAPER 78-WA/SOL-15] 21 p0164 A79-19847
- Recent advances in convectively cooled engine and airframe structures for hypersonic flight  
21 p0165 A79-20087
- Optimization and design of radiative heat-discharge system for energy unit with Stirling engine --- operating in planetary environment  
21 p0166 A79-20348
- Electric power losses of current input into superconducting devices cooled by supercritical helium  
22 p0235 A79-20530
- Design and operating experience of the cryogenic system of the U.S. SCMS as incorporated into the bypass loop of the U-25 MHD generator facility --- Superconducting Magnet System  
22 p0235 A79-20532
- Conceptual design of a superconducting tokamak - 'TORUS II SUPRA'  
22 p0236 A79-20543
- System performance predictions for solar cooling using regional stochastic weather models  
22 p0264 A79-23781
- The effects of internal latent energy storage on the operational dynamics of a solar-powered absorption cycle  
22 p0267 A79-24311
- Design of a heat pipe with separate channels for vapor and liquid  
22 p0268 A79-24486
- Selective covers for natural cooling devices --- in space  
22 p0272 A79-25522
- Solar absorption cooling feasibility  
22 p0295 A79-28358
- Problems in the use of cryogenic pumps in thermonuclear synthesis  
22 p0305 A79-30264
- Water-cooled gas turbine technology development - Fuels flexibility  
[ASME PAPER 79-GT-72] 22 p0307 A79-30536
- ICEC 7; Proceedings of the Seventh International Cryogenic Engineering Conference, London, England, July 4-7, 1978  
22 p0311 A79-31001
- Superconductivity in antenna engineering  
22 p0311 A79-31008
- Refrigeration requirements for future superconductive energy related applications  
22 p0311 A79-31019
- Solar heating and cooling system design and development  
[NASA-CR-150803] 21 p0172 A79-10516
- Optimum dry-cooling sub-systems for a solar air conditioner  
[NASA-TM-79007] 21 p0183 A79-11477
- Passive thermosyphon solar heating and cooling module with supplementary heating  
[NASA-CR-150849] 21 p0229 A79-15402
- Cooling systems addendum: Capital and total generating cost studies  
[PB-287306/5] 21 p0231 A79-15431
- Phase one/base data for the development of energy performance standards for new buildings. Climatic classification  
[PB-286900/6] 22 p0336 A79-16497
- COPPER**  
Copper/water axially-grooved heat pipes for RTG applications  
21 p0023 A79-10188
- Method for making an aluminum or copper substrate panel for selective absorption of solar energy  
[NASA-CASE-NPS-23518-1] 21 p0182 A79-11469
- COPPER ALLOYS**  
The structure and properties of Cu based selective surfaces formed on an Al-Cu alloy by chemical brightening and etching treatments --- for flat plate solar collectors  
21 p0127 A79-17384
- COPPER OXIDES**  
A copper oxide-copper sulfate water-splitting cycle  
21 p0015 A79-10128
- The structure and properties of Cu based selective surfaces formed on an Al-Cu alloy by chemical brightening and etching treatments --- for flat plate solar collectors  
21 p0127 A79-17384
- Explanation for low-efficiency Cu<sub>2</sub>O Schottky-barrier solar cells  
22 p0256 A79-22859
- COPPER SELENIDES**  
Suppression of vaporization in copper-silver-selenide thermoelectric materials  
21 p0027 A79-10224
- COPPER SULFIDES**  
Cu<sub>2</sub>S-CdS thin-film solar cells  
21 p0057 A79-13637
- The photovoltaic effect in CdS/Cu<sub>2</sub>S solar cells  
21 p0091 A79-15871
- Investigation on junction formation and realisation of high open-circuit voltage in Cu/x/S-CdS solar cells  
21 p0123 A79-17344
- Improvement of efficiency and stability by copper-treatment and front contacting of Cu/x/S-CdS solar cells  
21 p0123 A79-17345
- Sprayed CdS thin films for CdS/Cu<sub>2</sub>S heterojunction solar cells  
21 p0123 A79-17346
- The photovoltaic effects in CdS/Cu<sub>2</sub>S solar cells  
21 p0123 A79-17347
- Stoichiometric Cu<sub>2</sub>S thin films for solar cells  
21 p0123 A79-17349
- A pilot line for the production of large area Cu/x/S-CdS solar cells  
21 p0124 A79-17351
- The design and fabrication of CdS/Cu<sub>2</sub>S cells of 8.5-percent conversion efficiency  
22 p0300 A79-29428
- CORE SAMPLING**  
Microcrack technology for geothermal exploration and assessment  
[PB-290173/4] 22 p0367 A79-21530
- CORRELATION**  
Stochastic analysis of wind characteristics for energy conversion  
22 p0350 A79-18535
- CORROSION**  
Ash deposits and corrosion due to impurities in combustion gases; Proceedings of the International Conference, New England College, Henniker, N.H., June 26-July 1, 1977  
21 p0080 A79-14926
- Corrosion and deposits in MHD generator systems  
21 p0081 A79-14935

# SUBJECT INDEX

# COST EFFECTIVENESS

## CORROSION RESISTANCE

- Corrosion of superalloys, inconels, and stainless steels by the products from fluidized-bed coal combustion 21 p0080 A79-14932
- Corrosion and deposits from combustion of solid waste. VI - Processed refuse as a supplementary fuel in a stoker-fired boiler [ASME PAPER 78-WA/PU-4] 21 p0160 A79-19788
- Hot corrosion of Ni-base turbine alloys in atmospheres in coal-conversion systems 22 p0288 A79-27395
- Gas turbine operating and maintenance experience in Saudi Arabia 22 p0298 A79-28989
- State of the art and science report on design of alloys resistant to high-temperature corrosion-erosion in coal conversion environments [EPRI-PP-557] 21 p0200 A79-13149

## CORROSION TESTS

- Chloride corrosion and its inhibition in refuse firing 21 p0080 A79-14930
- Investigation of the corrosion performance of boiler, air heater, and gas turbine alloys in fluidized combustion systems 21 p0080 A79-14931
- Casing materials for sodium/sulfur cells 22 p0245 A79-21481

## COST ANALYSIS

- Simulation of solar powered Rankine cycle systems 21 p0022 A79-10179
- Solar and wind energy applications in Hawaii 21 p0066 A79-14265
- Breakdown of rapid rail energy costs - A study of three systems 21 p0068 A79-14323
- Total energy and labor requirements for an electric commuter railroad 21 p0068 A79-14325
- Life cycle costing of energy systems 21 p0072 A79-14683
- Barriers and incentives to the commercialization of solar heating and cooling of buildings 21 p0072 A79-14687
- Development of industrial owned, small hydroelectric facilities 21 p0073 A79-14699
- Status of photovoltaic systems and applications 21 p0095 A79-15907
- A methodological note on the evaluation of new technologies - The case of coal gasification 21 p0099 A79-16122
- Orbiting mirrors for terrestrial energy supply 21 p0108 A79-16605
- An analysis of air pollution control costs in N.S.W. --- New South Wales, Australia 21 p0115 A79-17228
- Cost of solar energy 21 p0118 A79-17291
- A comparison between sun and wind as energy sources in irrigation plants 21 p0118 A79-17295
- Costs and impacts of financial incentives for solar energy systems 21 p0119 A79-17296
- The interface with solar - Alternative auxiliary supply systems --- for solar space heating 21 p0137 A79-17468
- The economics of Fundy tidal power 21 p0152 A79-18112
- Universal generator storer curves --- Economic and relative size optimization of solar photovoltaic energy 22 p0238 A79-20799
- Costing the satellite power system [AAS PAPER 78-166] 22 p0243 A79-21270
- Solar Rankine engines - Examples and projected costs [ASME PAPER 79-SOL-3] 22 p0307 A79-30541
- Solar photovoltaic power for residential use [ASME PAPER 79-SOL-11] 22 p0308 A79-30546
- Structural cost optimization of photovoltaic central power station modules and support structure [ASME PAPER 79-SOL-17] 22 p0309 A79-30551
- Allowable costs for alternative domestic heating systems using utility supplied electricity for backup or charging energy 22 p0319 A79-31428

## Component cost of solar energy systems

- Cost analysis of new and retrofit hot-air type solar assisted heating systems [NASA-TN-78186] 21 p0173 A79-10519
  - Study of flywheel energy storage. Volume 4: Life-cycle costs [PB-282655/0] 21 p0177 A79-10558
  - Particulate and sulfur dioxide emission control costs for large coal-fired boilers [PB-281271/7] 21 p0178 A79-10591
  - Three modes of energy cost analysis: Then-current dollars, base-year dollars, and perpetual-constant dollars [ORAU/IEA(M)-78-10] 21 p0209 A79-13531
  - Analytical methods 21 p0218 A79-14531
  - Current and projected fuel costs --- electric rate schedules and projected costs of fossil, synthetic, and nuclear fuels 21 p0218 A79-14532
  - Results of systems analysis --- effectiveness of integrated solar energy systems 21 p0218 A79-14534
  - A detailed analysis of the impact of onsite equipment on utility costs --- marginal costs of providing backup power for solar energy systems 21 p0218 A79-14535
  - Satellite Power Systems (SPS) concept definition study. Volume 7: SPS program plan and economic analysis [NASA-CR-158068] 21 p0225 A79-15141
  - Cooling systems addendum: Capital and total generating cost studies [PB-287306/5] 21 p0231 A79-15431
  - Analysis and evaluation of process and equipment in tasks 2 and 4 of the Low Cost Solar Array project [NASA-CR-158089] 22 p0335 A79-16378
  - Comparative cost analyses: Total flow vs other power conversion systems for the Salton Sea Geothermal Resource [UCRL-52589] 22 p0342 A79-17337
  - LSA Low-cost Solar Array project [NASA-CR-158250] 22 p0355 A79-19462
  - Coal and nuclear: A comparison of the cost of generating baseload electricity by region [PB-289585/2] 22 p0355 A79-19469
  - Design of solar heating and cooling systems [AD-A062719] 22 p0363 A79-20522
  - Feasibility study of solar dome encapsulation of photovoltaic arrays [NASA-CR-158368] 22 p0367 A79-21545
  - Assessment of economic factors affecting the satellite power system. Volume 1: System cost factors [NASA-CR-161185] 22 p0368 A79-21551
  - The Brookhaven buildings energy conservation optimization model [BNL-50828] 22 p0370 A79-21564
- ## COST EFFECTIVENESS
- 100MWh zinc-chlorine peak-shaving battery plants 21 p0311 A79-10096
  - Cost effective solar collectors using heat pipes 21 p0014 A79-10115
  - Energy conversion in the long run 21 p0019 A79-10154
  - Comparative evaluation of distributed-collector solar thermal electric power plants 21 p0021 A79-10173
  - Army facility energy conservation 21 p0028 A79-10233
  - Direct energy converters - Efficiency and cost estimates for two electrostatic concepts 21 p0046 A79-12266
  - On the thermal and thermo-electrolytical generation of hydrogen by solar energy 21 p0059 A79-13660
  - Pennies a day - Financing early deployment of photovoltaic utility applications through a user subsidy [AIAA PAPER 78-1767] 21 p0061 A79-13866
  - Heat pumps without supplemental heat 21 p0073 A79-14695
  - A challenging role for the assurance sciences --- in energy conversion technology 21 p0086 A79-15396
  - Factors influencing solar energy commercialization 21 p0093 A79-15897

## COST ESTIMATES

Solar power satellites revisited 21 p0093 A79-15898

Materials problems in solar, nuclear and storage of energy 21 p0094 A79-15901

Identification of cost effective energy conservation measures 21 p0099 A79-16133

The use of lasers for the transmission of power 21 p0109 A79-16621

Compatibility of direct energy storage devices with ac. processing power system components 21 p0111 A79-16728

Solar Thermal Electric Program 21 p0112 A79-16730

Macro-energy model - Impact of public policy on technological development 21 p0113 A79-16741

Energy storage requirements for autonomous and hybrid solar thermal electric power plants 21 p0120 A79-17315

Simulation and cost of photovoltaic generators 21 p0122 A79-17334

Cost effective optimum design of solar air heaters 21 p0127 A79-17386

Economic use of materials in the design of solar water-heating collector plates of the pipe and fin type 21 p0129 A79-17396

Evacuated solar flat-plate collectors for economic applications 21 p0133 A79-17435

A cost effective total energy system using a faceted mirror sunlight concentrator and high intensity solar cells 21 p0135 A79-17446

An evaluation of the strategy of low cost horizontal axis windmills 21 p0143 A79-17517

Energy storage - Economics and fuel conservation 21 p0153 A79-18464

Conceptual design of large heat exchangers for ocean thermal energy conversion [ASME PAPER 78-WA/HT-32] 21 p0161 A79-19813

Cost-effectiveness of the vortex-augmented wind turbine 22 p0266 A79-24048

Do photovoltaics have a future [ASME PAPER 79-SOL-7] 22 p0308 A79-30543

Heat pump design - Cost effectiveness in the collection, storage and distribution of solar energy 22 p0313 A79-31316

A cost effective vertical air/water solar heating collector 22 p0320 A79-31430

Economic design of a solar domestic water heating system 22 p0321 A79-31438

P.E.I. solar assisted domestic water heat project 22 p0323 A79-31458

Solar energy - Four sites demonstrate potential 22 p0328 A79-32194

Statement of Doctor Robert A. Prosch, Administrator, National Aeronautics and Space Administration 21 p0224 A79-15111

The economics and engineering of large-scale algae biomass energy systems [PB-287868/4] 21 p0226 A79-15207

The effects of resource impact factors on energy conservation standards for buildings [PB-286909/7] 22 p0335 A79-16384

Life-cycle costing. A guide for selecting energy conservation projects for public buildings --- computing the cost effectiveness of retrofitting and new buildings [PB-287804/9] 22 p0345 A79-17744

**COST ESTIMATES**

Conceptual design and cost estimate 600 MWe coal fired fluidized-bed combined cycle power plant 21 p0008 A79-10068

A method for the comparative economic assessment of storage systems 21 p0013 A79-10111

Thermosyphon solar water heating system under Brazilian conditions 21 p0021 A79-10177

## SUBJECT INDEX

The fossil fuel cost of solar heating 21 p0022 A79-10180

Direct energy converters - Efficiency and cost estimates for two electrostatic concepts 21 p0046 A79-12266

A standard procedure of economic evaluation for energy-producing and pollution-abatement operations 21 p0064 A79-14109

Coal gasification and its alternatives 21 p0071 A79-14679

Assessing environmental costs of energy procurement 21 p0071 A79-14682

Steam raising with low-Btu gas generators and potential for other applications 21 p0072 A79-14690

An overview of the U.S. OTEC development program 21 p0100 A79-16247

OTEC power systems 21 p0101 A79-16248

Solar thermal conversion 21 p0104 A79-16466

Energy storage for tokamak reactor cycles --- during downtime for periodic plasma quench and reignition 21 p0111 A79-16727

Estimation of collector and electrical energy cost for STEPS in Japan --- Solar Thermal Electric Power System 21 p0118 A79-17288

Solar thermal electric power systems - Comparison of line-focus collectors 22 p0263 A79-23758

Laser power conversion system analysis, volume 1 [NASA-CR-159523-VOL-1] 22 p0366 A79-21334

**COST INCENTIVES**

Incentives and requirements for gasification based power systems 21 p0094 A79-15904

**COST REDUCTION**

Advances in lower cost phosphoric acid fuel cells 21 p0010 A79-10092

Cost minimization of photovoltaic power supplies 21 p0021 A79-10171

Solar thermal electric power systems

Manufacturing cost estimation and systems optimization 21 p0046 A79-12273

Economy in flight operations 21 p0048 A79-12383

High efficiency low cost solar cell power 21 p0048 A79-12471

Electricity from sunlight --- low cost silicon for solar cells 21 p0065 A79-14116

Heat recovery devices for building HVAC systems --- Heating Ventilating and Air Conditioning 21 p0073 A79-14697

Capital cost system optimization of OTEC power modules 21 p0101 A79-16249

Solar collectors. II - Recent developments and future performance data and economic analysis 21 p0103 A79-16456

Factors affecting market initiation of solar total energy 21 p0112 A79-16732

Non-adaptive optics for solar thermal electric power 21 p0112 A79-16733

The Power Wheel - Elimination of energy-consuming drive components 21 p0112 A79-16734

The status of solar energy --- for domestic water heating and thermal electric power generation 21 p0115 A79-17219

Concentrator photovoltaic systems for economical electricity and heat 21 p0124 A79-17354

Cheap packed bed absorbers for solar air heaters 21 p0128 A79-17388

Some aspects towards the performance evaluation and ensuing design components of solar collector systems 21 p0130 A79-17404

Optimal profile of solar energy collectors 21 p0130 A79-17408

Optimal distribution of heat conducting material in the finned pipe solar energy collector 22 p0242 A79-21163

# SUBJECT INDEX

# CRYOGENICS

- An overview of photovoltaic power systems  
[ASNE PAPER 79-SOL-12] 22 p0308 A79-30547  
Guide to reducing energy-use budget costs  
[HCP/U60505-01] 21 p0184 A79-11489
- COSTS**  
Economic impacts of a transition to higher oil  
prices --- estimation and budget allocations  
[BNL-50871] 22 p0364 A79-20927
- COUNTERFLOW**  
Limit of formation of counterflows in plane linear  
induction MHD machines 22 p0298 A79-29288
- COUPLED MODES**  
Local theory of finite-beta, collisional drift modes  
--- plasma stability analysis 22 p0253 A79-22244
- COVERINGS**  
Filon panels - A technical report --- fiberglass  
reinforced plastics for solar collectors  
21 p0031 A79-10403  
Effect of physical properties of a flat plate  
solar collector cover on efficiency calculations  
- Simplifying hypotheses 21 p0164 A79-19949
- CRACK INITIATION**  
Thermal stress cracking and the enhancement of  
heat extraction from fractured geothermal  
reservoirs  
[LA-7235-MS] 21 p0198 A79-12568
- CRACKING (FRACTURING)**  
Environmentally induced cracking of natural gas  
and liquid pipelines. Volume 2: Appendices A  
and B 21 p0181 A79-11446  
[PB-282924/0] 21 p0181 A79-11446  
Environmentally induced cracking of natural gas  
and liquid pipelines. Volume 1: Technical report  
[PB-282923/2] 21 p0181 A79-11447
- CROP IDENTIFICATION**  
Applying NASA remote sensing data to geologically  
related regional planning problems in Tennessee  
[E79-10095] 22 p0339 A79-17289
- CROSSED FIELDS**  
Theory of anomalous transport due to electrostatic  
fluctuations --- low frequency plasma  
instabilities of drift wave type 22 p0270 A79-24858
- CRUDE OIL**  
Petroleum plantations --- hydrocarbon fuels from  
artificial photosynthesis and plants  
21 p0095 A79-15910  
The effect of maturation on the configuration of  
pristane in sediments and petroleum 22 p0272 A79-25375  
Environmental development Plan (EDP). Oil supply,  
FY 1977 21 p0175 A79-10545  
[DOE/EDP-0024] 21 p0175 A79-10545  
Environmentally induced cracking of natural gas  
and liquid pipelines. Volume 2: Appendices A  
and B 21 p0181 A79-11446  
[PB-282924/0] 21 p0181 A79-11446  
Environmentally induced cracking of natural gas  
and liquid pipelines. Volume 1: Technical report  
[PB-282923/2] 21 p0181 A79-11447  
The department of Defense's alternate energy policy  
[AD-A058200] 21 p0197 A79-12563  
Proceedings of Energy Resource 5th Conference  
[PB-286246/4] 21 p0230 A79-15423  
GAO work involving title V of the Energy Policy  
and Conservation Act of 1975 21 p0230 A79-15424  
[PB-286400/7] 21 p0230 A79-15424  
Cooking with offshore oil: A handbook for  
California local government --- regional planning  
[PB-288656/2] 22 p0331 A79-16140  
Northern Alaska hydrocarbon resources  
[PB-287394/1] 22 p0332 A79-16342  
Catalyst evaluation for denitrogenation of  
petroleum residua and coal liquids, phase 5  
[PB-287180/4] 22 p0339 A79-17026  
Late diagenetic indicators of buried oil and gas.  
2: Direct detection experiment at Cement and  
Garza fields, Oklahoma and Texas, using enhanced  
Landsat 1 and 2 images  
[E79-10099] 22 p0347 A79-18373  
Aging behavior of crude shale oil  
[AD-A062420] 22 p0357 A79-20272  
Direct utilization of crude oil as fuel in the US  
Army four-cycle diesel engine, model 1DT-465-1C  
[AD-A062387] 22 p0357 A79-20279
- Economic impacts of a transition to higher oil  
prices --- estimation and budget allocations  
[BNL-50871] 22 p0364 A79-20927
- CRYOGENIC EQUIPMENT**  
Investigation of the thermophysical  
characteristics of cryogenic heat pipes with a  
metal-fiber wick 22 p0288 A79-27529  
High energy physics superconducting magnets and  
cryogenic systems --- review 22 p0290 A79-27663  
Cryogenic refrigeration, volume 2. A bibliography  
with abstracts 22 p0331 A79-16144  
[NTIS/PS-78/1261/3] 22 p0331 A79-16144  
Cryogenic refrigeration, volume 3. A bibliography  
with abstracts 22 p0331 A79-16145  
[NTIS/PS-78/1262/1] 22 p0331 A79-16145  
Transient shutdown analysis of low-temperature  
thermal diodes  
[NASA-TP-1369] 22 p0346 A79-18287
- CRYOGENIC FLUID STORAGE**  
The utilization of LH2 and LNG cold for generation  
of electric power by a cryogenic-type Stirling  
engine 22 p0311 A79-31020  
Liquefied natural gas safety research overview  
[AD-A063714] 22 p0365 A79-21233
- CRYOGENIC MAGNETS**  
Commercial realization of MHD - A challenge for  
superconducting magnets 21 p0084 A79-15302  
Cryogenic aspects of the U.S. SCMS superconducting  
dipole magnet for MHD research 21 p0084 A79-15303  
Fabrication experiences and operating  
characteristics of the U.S. SCMS superconducting  
dipole magnet for MHD research 21 p0084 A79-15304  
Design study of superconducting magnets for a  
combustion magnetohydrodynamic /MHD/ generator  
21 p0084 A79-15305  
Design of superconducting magnets for full-scale  
MHD generators 21 p0084 A79-15306  
Conductor for LANS 10-MWhr superconducting energy  
storage coil 21 p0085 A79-15309
- CRYOGENICS**  
Advances in cryogenic engineering. Volume 23 -  
Proceedings of the Conference, University of  
Colorado, Boulder, Colo., August 2-5, 1977  
21 p0084 A79-15301  
A new method for producing cryogenic laser fusion  
targets 21 p0085 A79-15332  
Development of cryogenic targets for laser fusion  
21 p0085 A79-15333  
Cryogenic pellets for laser-fusion research  
Theoretical and practical considerations 21 p0085 A79-15334  
Point-contact conduction-cooling technique and  
apparatus for cryogenic laser fusion pellets  
21 p0085 A79-15335  
Superconducting magnets --- for MHD applications  
21 p0105 A79-16485  
Electric power losses of current input into  
superconducting devices cooled by supercritical  
helium 22 p0235 A79-20530  
Design and operating experience of the cryogenic  
system of the U.S. SCMS as incorporated into the  
bypass loop of the U-25 MHD generator facility  
--- Superconducting Magnet System 22 p0235 A79-20532  
MIT-DOE program to demonstrate an advanced  
superconducting generator 22 p0236 A79-20549  
The cryogenic heat transfer tunnel - A new tool  
for convective research --- thermal efficiency  
testing of solar tower receiver 22 p0267 A79-24316  
Applications of cryogenic technology. Volume 7 -  
Proceedings of the Conference on Cryogenic  
Energy Systems, Oak Brook, Ill., May 16-18, 1978  
22 p0289 A79-27651  
Problems in the use of cryogenic pumps in  
thermonuclear synthesis 22 p0305 A79-30264

# CRYOPUMPING

- ICEC 7; Proceedings of the Seventh International Cryogenic Engineering Conference, London, England, July 4-7, 1978 22 p0311 A79-31001
- Cryogenic technology and superconductivity in controlled fusion 22 p0311 A79-31003
- Superconductivity in antenna engineering 22 p0311 A79-31008
- Refrigeration requirements for future superconductive energy related applications 22 p0311 A79-31019

# CRYOPUMPING

- Large-scale cryopumping for controlled fusion 21 p0085 A79-15330

# CRYOSTATS

- A superconducting dipole magnet system for the MHD facility at Univ. of Tennessee Space Institute 21 p0017 A79-10140
- Cryogenic aspects of the U.S. SCMS superconducting dipole magnet for MHD research 21 p0084 A79-15303
- A superconducting dipole magnet for the UTSI MHD Facility 22 p0235 A79-20533

# CRYSTAL DEFECTS

- Spectral characteristics of photoconverters with nonuniform defect distribution in the base 21 p0053 A79-13289

# CRYSTAL GROWTH

- Large area silicon sheet by EFG --- Edge-defined Film-fed Growth 21 p0123 A79-17340
- Silicon solar cells, volume 3. Citations from the NTIS data base [NTIS/PS-78/1115/1] 21 p0212 N79-13555
- Silicon solar cells, volume 2. Citations from the NTIS data base [NTIS/PS-78/1116/9] 21 p0212 N79-13556
- Slicing of silicon into sheet material: Silicon sheet growth development for the large area silicon sheet task of the Low Cost Silicon Solar Array project [NASA-CR-158082] 22 p0333 N79-16365
- Continuous Czochralski growth: Silicon sheet growth development of the large area silicon sheet task of the Low Cost Silicon Solar Array project [NASA-CR-158096] 22 p0334 N79-16369
- Analysis and evaluation of process and equipment in tasks 2 and 4 of the Low Cost Solar Array project [NASA-CR-158089] 22 p0335 N79-16378
- Silicon web process development [NASA-CR-158376] 22 p0357 N79-20282
- Large area silicon sheet by EFG [NASA-CR-158379] 22 p0359 N79-20483

# CRYSTAL OPTICS

- Review of theories for predicting  $n_2$  in glasses and crystals --- refractive index of fusion laser materials 21 p0083 A79-15139

# CRYSTAL STRUCTURE

- Hydrogen storage in FeTi - Surface segregation and its catalytic effect on hydrogenation and structural studies by means of neutron diffraction 22 p0312 A79-31156

# CURRENT DENSITY

- Migrational polarization in high-current density molten salt electrochemical devices 21 p0039 A79-11811
- Electromagnetic excitation of a moving conducting piston 22 p0237 A79-20658

# CURRENT DISTRIBUTION

- Attenuating the transverse edge effect in MHD generators 21 p0063 A79-13985
- MHD equilibrium and stability --- in tokamak devices 21 p0078 A79-14779
- Effects of position of output electrodes in entrance region of open-cycle diagonal type MHD generator 21 p0153 A79-18468
- Structure of the current shell in a Z pinch 22 p0245 A79-21434

# SUBJECT INDEX

- Three-dimensional effects of electrode configuration on diagonal MHD generator performance 22 p0283 A79-26523
- The effect of limiters and current profile on elliptic free-boundary MHD equilibria 22 p0291 A79-27881
- CURRENT REGULATORS**  
Advancements in the design of solar array to battery charge current regulators 21 p0033 A79-10902
- CURRENT SHEETS**  
Investigation of a staged plasma-focus apparatus --- pinch construction and current sheet dynamics investigation 22 p0255 A79-22365
- CURVATURE**  
Effect of surface curvature on measurement of the absorptance properties of solar coatings 21 p0042 A79-11879
- CURVED BEAMS**  
Flexed beams in central receiver heliostat drives [AIAA PAPER 78-1755] 21 p0060 A79-13856
- CYCLOTRON FREQUENCY**  
Electron-cyclotron heating in high density toroidal plasmas 22 p0265 A79-24037
- Non-thermal emission at the plasma frequency --- spectra obtained on tokamak fusion reactors 22 p0270 A79-24854
- Magneto-acoustic resonance heating in the ion-cyclotron frequency domain --- of tokamak plasmas 22 p0271 A79-24866
- Wave propagation and absorption near the electron-cyclotron layer in the 'THOR' device --- microwave heating of tokamak plasma 22 p0271 A79-24867
- CYCLOTRON RADIATION**  
The contribution of plasma dielectric properties to the cyclotron radiation spectrum from a tokamak plasma 22 p0312 A79-31183
- Interpretation of cyclotron radiation spectra from runaway discharges in TFR 22 p0313 A79-31185
- CYCLOTRON RESONANCE**  
Present status of two R.F. heating schemes - I.C.R.H. and L.H.R.H. --- Ion Cyclotron Resonant Heating and Lower-Hybrid Resonant Heating of plasma 21 p0071 A79-14467
- Electrons of high perpendicular energy in the low-density regime of tokamaks 22 p0270 A79-24852
- RF-heating in stationary systems --- of toroidal plasma in tokamaks 22 p0271 A79-24864
- Magneto-acoustic resonance heating in the ion-cyclotron frequency domain --- of tokamak plasmas 22 p0271 A79-24866
- Characteristics of electron-cyclotron-resonance-heated tokamak power reactors 22 p0292 A79-27885
- CYLINDRICAL BODIES**  
An analysis of a cylindrical parabolic focussing collector for distributed collector power system 21 p0134 A79-17442
- Geometrical aspects of a cylindrical parabolic collector 21 p0134 A79-17443
- Performance of solar concentrators - A theoretical study 21 p0135 A79-17453
- A theory for wave-power absorption by two independently oscillating bodies 22 p0259 A79-23307
- Symmetrical and asymmetrical ideal cylindrical radiation transformers and concentrators 22 p0303 A79-29647
- CYLINDRICAL CHAMBERS**  
Numerical computation of the loss coefficients for evacuated cylindrical collector receiver tubes [ASHE PAPER 78-WA/SOL-3] 21 p0162 A79-19836
- CYLINDRICAL WAVES**  
Analysis of a cylindrical imploding shock wave 21 p0155 A79-18846

## SUBJECT INDEX

## DECOMPOSITION

## CZOCHEHALSKI METHOD

LSA large area silicon sheet task continuous  
liquid feed Czochralski growth  
[NASA-CR-158366] 22 p0357 N79-20281

## D

## DAMPING

Lag damping in autorotation by a perturbation method  
--- for rigid rotor blades  
[AHS 78-25] 21 p0152 A79-18151  
Power train analysis for the DOE/NASA 100-kW wind  
turbine generator  
[NASA-TN-78997] 22 p0333 N79-16355

## DATA ACQUISITION

A theoretical method for the prediction of monthly  
mean solar radiation parameters  
21 p0022 A79-10183  
Analysis of data user's needs for performance  
evaluation of solar heating and cooling systems  
21 p0087 A79-15827  
Collection of data for estimating the probable  
life cycle costs of solar energy systems  
21 p0087 A79-15828  
Acceleration of solar heating application via  
improved data evaluation  
21 p0087 A79-15829

Considerations in choosing solar energy monitoring  
systems  
21 p0087 A79-15831

Data acquisition using a modular data logger ---  
for solar heated building monitoring  
21 p0088 A79-15832

Experience gained and lessons learned from  
monitoring the solar building, Albuquerque  
21 p0088 A79-15833

The use of computer-controlled data acquisition  
systems in determining solar heating and cooling  
system performance  
21 p0088 A79-15834

Instrumentation, data acquisition and monitoring  
system for an air heating solar system  
21 p0088 A79-15836

Moderate cost, calculator-based data acquisition  
for solar HVAC systems  
21 p0088 A79-15837

Design of the data acquisition system at Solar One  
--- home energy monitoring via minicomputers  
21 p0088 A79-15841

Low-cost monitoring of solar system performance  
21 p0088 A79-15843

Sensor selection and placement in the National  
Solar Data Program  
21 p0089 A79-15844

A minicomputer based data acquisition and analysis  
systems for vertical axis wind turbine testing  
21 p0144 A79-17617

Solar Total Energy Control Data Acquisition System  
21 p0144 A79-17618

Master control and data system for the SNW Solar  
Thermal Test Facility  
21 p0144 A79-17620

Wind power site evaluation. I - Wind energy  
potential. II - Data acquisition and processing  
22 p0257 A79-22924

Statistical analysis of solar radiation data in  
Montreal for solar energy utilization  
22 p0322 A79-31452

Data acquisition and signal processing for a  
vertical axis wind energy conversion system  
[SAND-78-1000C] 21 p0187 N79-11517

## DATA BASES

Bibliographic and numeric data bases for fiber  
composites and matrix materials  
21 p0114 A79-16984

End use energy consumption data base: Series 1  
tables  
[PB-281817/7] 21 p0177 N79-10560

Energy information data base. Guide to  
abstracting and indexing  
[TID-4583-R1] 21 p0184 N79-11488

Energy information data base: Serial titles  
[TID-4579-R10] 21 p0197 N79-12566

Geothermal emissions data base: Cerro Prieto  
geothermal field  
[UCID-4033] 21 p0204 N79-13480

Industrial international data base: Energy  
analysis methodology. Rational use of energy  
program pilot study  
[NATO/CCHS-75] 21 p0206 N79-13508

Solar Irrigation Program Data Base Management  
System (SIPDBMS)  
[SAND-78-0641] 21 p0209 N79-13532

Environmental assessment data base for high-Btu  
gasification technology. Volume 1: Technical  
discussion  
[PB-288602/6] 22 p0350 N79-18487

Environmental assessment data base for high-Btu  
gasification technology. Volume 2: Appendices  
A, B, and C  
[PB-288603/4] 22 p0350 N79-18488

Environmental assessment data base for high-Btu  
gasification technology. Volume 3: Appendices  
D, E, and F  
[PB-288604/2] 22 p0350 N79-18489

## DATA PROCESSING

Application of LANDSAT data and digital image  
processing --- Ruhr Valley, Germany  
[E79-10102] 22 p0339 N79-17291

## DATA RECORDERS

Data acquisition using a modular data logger ---  
for solar heated building monitoring  
21 p0088 A79-15832

## DATA SYSTEMS

Federal Energy Data System (PEDS) technical  
documentation  
[PB-281815/1] 21 p0189 N79-11542

National Emissions Data System (NEDS) fuel use  
report (1974)  
[PB-284658/2] 21 p0194 N79-12251

Coal research: Data systems and information  
transfer  
[ORAU-133] 21 p0232 N79-15830

## DECISION MAKING

A multivariate-utility approach for selection of  
energy sources  
21 p0098 A79-16120

A methodology for evaluating the worth of a new  
energy resource with particular reference to  
wind energy utilisation in rural areas  
21 p0143 A79-17514

Optimal decisions for long-term operation of  
hydropower systems  
22 p0245 A79-21473

Energy availabilities for state and local  
development: Projected energy patterns for 1980  
and 1985  
[ORNL/TM-5890/54] 21 p0186 N79-11511

Energy and the economy  
[EPRI-EA-620-VOL-1] 21 p0189 N79-11539

Industrialization study --- impact of government  
incentives and barriers on decision making in  
the industrial production of photovoltaics  
[NASA-CR-157953] 21 p0200 N79-12970

Research and development needs to merge  
environmental and energy objectives  
[GPO-23-254] 22 p0342 N79-17339

The development of a laser Doppler velocimetry  
system for unsteady separated flow research:  
Preliminary results  
[AD-A061724] 22 p0352 N79-19305

## DECISION THEORY

Conference on Decision and Control, and Symposium  
on Adaptive Processes, 16th, and Special  
Symposium on Fuzzy Set Theory and Applications,  
New Orleans, La., December 7-9, 1977,  
Proceedings. Volumes 1 & 2  
21 p0081 A79-14957

Thermal power systems small power systems  
applications project. Decision analysis for  
evaluating and ranking small solar thermal power  
system technologies. Volume 1: A brief  
introduction to multiattribute decision analysis  
--- explanation of multiattribute decision  
analysis methods used in evaluating alternatives  
for small powered systems  
[NASA-CR-158425] 22 p0368 N79-21548

## DECOMPOSITION

Problems around Fe-Cl cycles --- thermochemical  
decomposition of water hydrogen production  
22 p0238 A79-20771

# DEFENSE PROGRAM

# SUBJECT INDEX

## DEFENSE PROGRAM

The national energy plan: Options under assumptions of national security threat --- economic impact procurement policy, and resources management  
[H-PRINT-95-48] 21 p0228 A79-15398

**DEGRADATION**  
MHD power generation: Research, development and engineering  
[PE-3087-2] 22 p0363 A79-20518

**DEHUMIDIFICATION**  
Rate of desorption in a solar regenerator 21 p0055 A79-13611  
Buoyancy effects in a solar regenerator --- for air dehumidifier absorbent solutions 22 p0262 A79-23752

**DELAYED FLAP APPROACH**  
Dynamic simulation studies of fuel conservation procedures used in terminal areas 22 p0259 A79-23581

**DEMAND (ECONOMICS)**  
Factors influencing solar energy commercialization 21 p0093 A79-15897  
Energy availabilities for state and local development: 1973 data volume [ORNL/TM-5890-S2] 21 p0175 A79-10541  
Energy availabilities for state and local development: 1974 data volume [ORNL/TM-5890-S3] 21 p0175 A79-10542  
Future aviation fuels fuel suppliers views 21 p0202 A79-13194  
Calculation of backup requirements 21 p0218 A79-14533  
US energy demand and supply, 1976-1985: Limited options, unlimited constraints [H-PRINT-95-43] 21 p0228 A79-15400  
Symposium on Energy Today and Tomorrow [CSIR-S-145] 22 p0340 A79-17316  
The planning and economic aspects of energy supply and demand in South Africa 22 p0341 A79-17325  
Alternative models of energy demand 22 p0353 A79-19440

**DENITROGENATION**  
Catalyst evaluation for denitrogenation of petroleum residua and coal liquids, phase 5 [PB-287180/4] 22 p0339 A79-17026

**DENMARK**  
Solar energy use in Denmark /56 deg N/ and higher latitudes in Scandinavia 21 p0128 A79-17393  
CCMS solar energy pilot study reporting format - The zero energy house in Denmark 22 p0277 A79-25940

**DENSE PLASMAS**  
Review of results from DTF tokamak 21 p0069 A79-14456  
Investigation of a staged plasma-focus apparatus --- pinch construction and current sheet dynamics investigation 22 p0255 A79-22365  
A simple neutral density profile calculation for tokamaks with lambda sub mfp much smaller than a 22 p0255 A79-22379  
Electron cyclotron heating in high density toroidal plasmas 22 p0265 A79-24037  
Recombination-induced neutral-particle flux in tokamaks 22 p0291 A79-27877

**DENSITOMETERS**  
Liquid mixture excess volumes and total vapor pressures using a magnetic suspension densimeter with compositions determined by chromatographic analysis Methane plus ethane 21 p0085 A79-15324

**DENSITY DISTRIBUTION**  
A simple neutral density profile calculation for tokamaks with lambda sub mfp much smaller than a 22 p0255 A79-22379  
The effect of thermo-electric forces on the density profiles in a thermonuclear plasma surrounded by a cold blanket 22 p0292 A79-27886

## DENSITY MEASUREMENT

Liquid mixture excess volumes and total vapor pressures using a magnetic suspension densimeter with compositions determined by chromatographic analysis Methane plus ethane 21 p0085 A79-15324  
Measurements of compressed core density of laser-imploded targets by x-ray continuum-edge shift 21 p0154 A79-18479  
Plasma density measurements on refuelling by solid hydrogen pellets in a rotating plasma 22 p0255 A79-22369

**DEPOSITION**  
Thermophoresis - Enhanced deposition rates in combustion turbine blade passages [ASHE PAPER 78-WA/GT-1] 21 p0160 A79-19790

**DEPOSITS**  
High sulfur fuel effects in a two-cycle high speed army diesel engine [AD-A059534] 21 p0216 A79-14232

**DESALINIZATION**  
Sea water desalination by means of solar energy 21 p0057 A79-13645  
The use of wave powered systems for desalination - A new opportunity --- seawater pumping for reverse osmosis 21 p0151 A79-18108  
East Mesa geothermal test site 22 p0259 A79-23458

**DESICCANTS**  
Liquid desiccant solar air conditioner and energy storage system 21 p0021 A79-10176  
Simulations of the performance of open cycle desiccant systems using solar energy 21 p0066 A79-14262  
Solid desiccant air conditioning with silica gel using solar energy 21 p0181 A79-11464

**DESIGN ANALYSIS**  
Design considerations for an in situ gasification test of eastern bituminous coals 21 p0005 A79-10049  
Optimum design conditions for a power plant at a vapor dominated geothermal resource, Pacific Gas and Electric's The Geysers Power Plant Unit 16 21 p0014 A79-10121  
Design studies and trade-off analyses for a superconducting magnet/MHD power generator system 21 p0017 A79-10142  
Design, construction, and testing of a Fixed Mirror Solar Concentrator field 21 p0020 A79-10164  
Energy conservation aircraft design and operational procedures [ONERA, TP NO. 1978-107] 21 p0036 A79-11572  
General principles of multielement concentrating system design --- solar collectors 21 p0054 A79-13291  
Selection of method for calculating the parameters of wind and solar power station storage facilities 21 p0054 A79-13293  
Design of a second generation concentrating tracking solar collector [AIAA PAPER 78-1775] 21 p0062 A79-13872  
Design optimization for solar array of multiple collector types 21 p0071 A79-14677  
The improved rigid airship --- design characteristics and cost analysis 21 p0086 A79-15572  
Acceleration of solar heating application via improved data evaluation 21 p0087 A79-15829  
Solar energy and the flat plate collector - An annotated bibliography 21 p0090 A79-15858  
Design of active solar heating systems 21 p0090 A79-15860  
Layout and design characteristics of MHD power stations 21 p0105 A79-16481  
MHD generators --- Paraday, Hall and diagonal generator designs 21 p0105 A79-16484  
Design considerations for solar power satellites 21 p0113 A79-16738



# SUBJECT INDEX

# DEUTERIUM PLASMA

- Temperature dependent parameter analysis of thermoelectric devices 21 p0113 A79-16740
- On the design of CPC photovoltaic solar collectors --- Compound Parabolic Concentrator 21 p0124 A79-17355
- Design and optimization of a flat plate collector for cooling application 21 p0132 A79-17419
- Flat plate collector - Experimental studies and design data for India 21 p0132 A79-17425
- P.E.R.I.C.L.E.S. - Design of a stationary spherical collector --- solar energy application 21 p0134 A79-17441
- Design fabrication and testing of three meter diameter parabolic dish heliostat system 21 p0135 A79-17447
- Two thermodynamic optima in the design of sensible heat units for energy storage 21 p0150 A79-18091
- Preliminary analysis of advanced ceramic magnetohydrodynamic /MHD/ combustor design concepts 22 p0240 A79-20838
- Analysis and design of a field of heliostats for a solar power plant 22 p0242 A79-21161
- Some flow analyses for Tornado-type wind turbines 22 p0279 A79-26181
- Analysis and design of air heating unglazed flat plate solar collectors 22 p0280 A79-26202
- First-order design variables for concentrating solar collectors 22 p0293 A79-28141
- Fiat Research Center hybrid vehicle prototype [SAE PAPER 790014] 22 p0313 A79-31351
- Electric vehicle battery development [SAE PAPER 790158] 22 p0314 A79-31363
- Solar heating and cooling system design and development [NASA-CR-150803] 21 p0172 A79-10516
- Preliminary design package for Sunair SEC-601 solar collector [NASA-CR-150875] 22 p0341 A79-17332
- A 200-kW wind turbine generator conceptual design study [NASA-TM-79032] 22 p0341 A79-17333
- Evaluation of the ECAS open cycle MHD power plant design [NASA-TM-79012] 22 p0341 A79-17335
- Satellite Power System (SPS) concept definition study (exhibit C) [NASA-CR-161173] 22 p0352 A79-19071
- Solar heating of buildings: Design optimization and economic analysis 22 p0353 A79-19439
- MHD-ETP program. Volume 1: Executive summary [FE-2613-6-VOL-1] 22 p0362 A79-20515
- MHD-ETP program. Volume 2A, parts 1 and 2: Reference design description [FE-2613-6-VOL-2A] 22 p0363 A79-20516
- Engineering test facility conceptual design, part 1 [FE-2614-2-PT-1] 22 p0369 A79-21560
- Engineering test facility conceptual design, part 2 [FE-2614-2-PT-2] 22 p0369 A79-21561
- DESORPTION**
- Study of the interaction of H<sub>2</sub>O and O<sub>2</sub> with the surface of TiO<sub>2</sub> by electron stimulated desorption and Auger and characteristic loss spectroscopies 21 p0037 A79-11793
- Absorption of hydrogen by the intermetallics Ni<sub>3</sub>Si and LaNi<sub>4</sub>Cu and a correlation of cell volumes and desorption pressures 21 p0038 A79-11804
- Rate of desorption in a solar regenerator 21 p0055 A79-13611
- Kinetics of hydrogen absorption and desorption --- for energy storage 22 p0248 A79-21687
- DESULFURIZING**
- Coal desulfurization: Chemical and physical methods; Proceedings of the Symposium, New Orleans, La., March 23, 1977 21 p0044 A79-12114
- An overview of coal preparation --- for producing clean fuel through desulfurization 21 p0044 A79-12115
- Desulfurization of coals by high-intensity high-gradient magnetic separation - Conceptual process design and cost estimation 21 p0044 A79-12116
- Applicability of the Meyers process for desulfurization of U.S. coal - A survey of 35 coals --- through chemical leaching 21 p0044 A79-12117
- Coal desulfurization test plant status - July 1977 --- utilizing Meyers leach process 21 p0044 A79-12118
- Coal desulfurization by low-temperature chlorinolysis 21 p0045 A79-12119
- Desulfurization and sulfidation of coal and coal char 21 p0045 A79-12120
- Fluid-bed carbonization/desulfurization of Illinois coal by the Clean Coke Process - PDU studies --- Process Development Unit 21 p0045 A79-12121
- Recent operating experience of the Wellman-Lord PGD process on a coal-fired boiler --- flue gas desulfurization 21 p0065 A79-14120
- The Research-Cottrell/Bahco SO<sub>2</sub> and particulate removal system at Rickenbacker Air Force Base 21 p0065 A79-14122
- Energy requirements of a limestone PGD system --- Flue Gas Desulfurization 21 p0114 A79-16747
- Assessment of current flue gas desulfurization technology 21 p0145 A79-17637
- Operating experience with three 20 MW prototype flue gas desulfurization processes [ASME PAPER 78-JPGC-PWR-12] 21 p0150 A79-18098
- Catalytic hydrodesulfurization and liquefaction of coal - Batch autoclave studies 22 p0282 A79-26465
- Coke formation on hydrodesulfurization catalysts 22 p0283 A79-26470
- Flue gas desulfurization system capabilities for coal-fired stream generators, volume 1. Executive summary [PB-284045/2] 21 p0200 A79-12606
- Coal desulfurization using microwave energy [PB-285880/1] 21 p0216 A79-14243
- Demetalization catalyst tests on heavy residual oils [PB-285937/9] 21 p0232 A79-15864
- Assessment of coal cleaning technology [PB-287091/3] 22 p0330 A79-16139
- Catalyst aging tests and the role of catalyst wetting on hydrodesulfurization of a coal derived liquid 22 p0352 A79-19169
- Assessment of coal cleaning technology: An evaluation of chemical coal cleaning processes [PB-289493/9] 22 p0372 A79-21625
- Evaluation of dry sorbents and fabric filtration for PGD (Flue Gas Desulfurization) [PB-289921/9] 22 p0373 A79-21661
- DETONATION WAVES**
- Mathematical models of direct initiation of unconfined gas phase detonations --- hazards of LNG/air clouds from spills [AIAA PAPER 79-0289] 21 p0157 A79-19649
- DEUTERIUM**
- Nuclear characteristics of D-D fusion reactor blankets - Technical data 21 p0162 A79-19826
- High temperature thermodynamics of the solid solutions of hydrogen and deuterium in palladium and in the Pd<sub>0.9</sub>Ag<sub>0.1</sub> alloy 22 p0249 A79-21689
- DEUTERIUM PLASMA**
- Overview of inertial confinement fusion reactor designs 21 p0018 A79-10149
- Compact experiments for alpha-particle heating --- of confined D-T plasma in tokamak 21 p0078 A79-14786

## DEVELOPING NATIONS

- Radially resolved measurements of 'q' on the adiabatic toroidal compressor tokamak --- safety factor 21 p0155 A79-18830
- Structure of the current shell in a Z pinch 22 p0245 A79-21434
- Cyclotron-wave spectrum in a plasma with two ion species 22 p0245 A79-21443
- The synergetics of the catalytic D-D-fusion-fission breeder 22 p0252 A79-22236
- Alpha transport and blistering in tokamaks 22 p0253 A79-22243
- Prepulse damage to targets and alignment verification 22 p0258 A79-23027
- Fuel content characterization and pressure retention measurements of DT-filled laser fusion microballoon targets 22 p0258 A79-23034
- Pellet X-ray spectra for laser fusion reactor designs 22 p0291 A79-27878
- Calculation of the Q factor for a two-component tokamak 22 p0324 A79-31763

## DEVELOPING NATIONS

- Prospects for harnessing renewable energy sources in developing countries 21 p0117 A79-17286
- Energy balances as a means for the evaluation of solar energy in developing countries 21 p0118 A79-17290
- Bio-mass energy for rural areas 21 p0126 A79-17373
- Photovoltaic power systems for rural areas of developing countries 22 p0278 A79-26131
- Modern technology for recovering energy and materials from urban wastes - Its applicability in developing countries 22 p0295 A79-28183
- Solar energy in developing countries: An overview and 'buyers' guide for solar scientists and engineers --- Book 22 p0327 A79-32139
- Energy needs, uses, and resources in developing countries [BNL-50784] 21 p0185 A79-11500
- Analytical framework for the assessment of energy resource and technology options for developing countries [BNL-50800] 21 p0208 A79-13524
- Photovoltaic power systems for rural areas of developing countries [NASA-TM-79097] 21 p0229 A79-15411

## DIAGRAMS

- Solar energy diagrams --- combining position and insolation data 22 p0253 A79-22267

## DIELECTRIC PROPERTIES

- The contribution of plasma dielectric properties to the cyclotron radiation spectrum from a tokamak plasma 22 p0312 A79-31183

## DIESEL ENGINES

- Dynamic characteristics of a free-piston diesel engine combined with a HED generator 22 p0258 A79-23137
- The emissions and fuel economy of a Detroit diesel 6-71 engine burning a 10-percent water-in-fuel emulsion [AD-A058550] 21 p0203 A79-13375
- High sulfur fuel effects in a two-cycle high speed army diesel engine [AD-A059534] 21 p0216 A79-14232
- Air quality assessment of particulate emissions from diesel-powered vehicles [PB-286172/2] 21 p0223 A79-14641
- Performance characteristics of automotive engines in the United States. Second series, report no. 6: 1976 Nissan diesel 198 CID (3.2 liters), P. I. [PB-286295/1] 21 p0227 A79-15309
- Comparison of fuel-cell and diesel integrated energy systems and a conventional system for a 500-unit apartment [NASA-TM-79037] 21 p0229 A79-15403

## SUBJECT INDEX

- Proceedings of symposium on water-in-fuel emulsions in combustion --- marine diesels, boilers, and gas turbine engines [AD-A061503] 22 p0338 A79-17019
- Direct utilization of crude oil as fuel in the US Army four-cycle diesel engine, model LDT-465-1C [AD-A062387] 22 p0357 A79-20279
- Single-cylinder diesel engine tests with unstabilized water-in-fuel emulsions [AD-A062751] 22 p0366 A79-21406
- DIESEL FUELS**
- A literature review-problem definition studies on selected toxic chemicals. Volume 1: Occupational health and safety aspects of diesel fuel and white smoke generated from it [AD-A056018] 21 p0192 A79-11686
- A literature review-problem definition studies on selected toxic chemicals. Volume 8: Environmental aspects of diesel fuel and fog oils SGP number 1 and SGP number 2 and smoke screens generated from them [AD-A056021] 21 p0193 A79-11688
- High sulfur fuel effects in a two-cycle high speed army diesel engine [AD-A059534] 21 p0216 A79-14232
- Fundamental combustion studies of emulsified fuels for diesel applications [PB-287386/7] 22 p0330 A79-16138
- Parametric performance of a turbojet engine combustor using jet A and A diesel fuel [NASA-TM-79089] 22 p0357 A79-20114
- Health effects associated with diesel exhaust emissions, literature review and evaluation [PB-289817/9] 22 p0364 A79-20727
- Dependence of the pour point of diesel fuels on the properties of the initial components [NASA-TM-75424] 22 p0364 A79-21217
- Single-cylinder diesel engine tests with unstabilized water-in-fuel emulsions [AD-A062751] 22 p0366 A79-21406
- DIFFUSE RADIATION**
- A theoretical method for the prediction of monthly mean solar radiation parameters 21 p0022 A79-10183
- The relationship between diffuse and total solar radiation in computer simulation of solar energy systems 21 p0119 A79-17304
- Hourly vs daily method of computing insolation on inclined surfaces 22 p0242 A79-21164
- Diffuse solar radiation on a horizontal surface for a clear sky 22 p0242 A79-21167
- Isotropic distribution approximation in solar energy estimations --- diffuse insolation on tilted surface 22 p0262 A79-23753
- Thermodynamics of the conversion of diluted radiation --- solar energy application 22 p0310 A79-30910
- Statistical analysis of solar radiation data in Montreal for solar energy utilization 22 p0322 A79-31452
- DIFFUSERS**
- Experimental demonstration of the Diffuser Augmented Wind Turbine concept 21 p0029 A79-10238
- Fluid dynamics of diffuser-augmented wind turbines 22 p0238 A79-20798
- Diffuser designs for improved wind energy conversion 22 p0279 A79-26182
- Subsonic diffusers for HED generators 22 p0279 A79-26185
- On supersonic and subsonic diffusers for magnetohydrodynamic generator applications 22 p0279 A79-26186
- DIFFUSION COEFFICIENT**
- Study of diffusion processes in low-temperature thermopiles --- for solar energy conversion 21 p0054 A79-13290
- Effect of grain boundaries in silicon on minority-carrier diffusion length and solar-cell efficiency 22 p0252 A79-21807
- DIFFUSION ELECTRODES**
- Influence of composition on the activity of tungsten carbide gas diffusion hydrogen electrodes 22 p0245 A79-21482

# SUBJECT INDEX

# DOMESTIC ENERGY

- Influence of the electrolyte content of oxygen carbon gas-diffusion electrodes on their electro-chemical performance in acid solutions  
22 p0245 A79-21483
- DIFFUSION PLANES**  
Influences on exhaust emissions from automotive gas turbines  
[ASME PAPER 78-GT-85] 22 p0255 A79-22338
- DIFFUSIVITY**  
Electrochemical determinations of the chemical potential and diffusivity of sodium in Na/x/TaS<sub>2</sub> at 300 K  
21 p0040 A79-11830
- DIGITAL DATA**  
Application of LANDSAT data and digital image processing --- Ruhr Valley, Germany  
[E79-10102] 22 p0339 N79-17291
- DIGITAL SIMULATION**  
Dynamic computer simulation of the DOE 10 MW solar thermal pilot plant  
[AIAA PAPER 78-1752] 21 p0060 A79-13854  
Control of wind turbine generators connected to power systems  
21 p0086 A79-15574  
Fast penetration of a magnetic field into a low-density plasma  
22 p0244 A79-21432  
Structure of the current shell in a Z pinch  
22 p0245 A79-21434  
Non-linear numerical algorithms for studying tearing modes --- in tokamaks  
22 p0257 A79-22981  
Digital or analog modelling in the design of hydrostatic vehicular systems  
22 p0264 A79-23808  
WATSON - A simulation program for solar-assisted heating systems  
22 p0321 A79-31439  
Initial comparison of single cylinder Stirling engine computer model predictions with test results  
[NASA-TM-79044] 22 p0337 N79-16721
- DILUTION**  
Solar thermal energy storage using heat of dilution - Analysis of heat generation in multistage mixing column  
21 p0046 A79-12271
- DIODES**  
Cooling applications of thermic diode panels  
[ASME PAPER 78-WA/SOL-10] 21 p0163 A79-19842  
Transient shutdown analysis of low-temperature thermal diodes  
[NASA-TP-1369] 22 p0346 N79-18287
- DIRECT CURRENT**  
Compatibility of direct energy storage devices with ac. processing power system components  
21 p0111 A79-16728
- DIRECT POWER GENERATORS**  
Electric power from laser fusion - The HYLIPE concept  
21 p0030 A79-10249  
Design of a direct wind energy converter to heat water by agitation in a closed tank  
21 p0067 A79-14290  
Solar electricity production  
21 p0104 A79-16467  
Direct photoelectrochemical conversion and storage of solar energy  
21 p0126 A79-17370  
Feasibility of MHD-ac induction electric power plant --- using tokamak reactor exhaust plasma  
22 p0303 A79-29794  
Mini-BRU/EIPS 1300 watt (sub) dynamic power conversion system development: Executive summary  
[NASA-CR-159440] 21 p0173 N79-10526
- DIRECTIONAL ANTENNAS**  
Large active retrodirective arrays for solar power satellites  
21 p0107 A79-16604  
Solar power satellite rectenna design study: Directional receiving elements and parallel-series combining analysis  
[NASA-CR-151866] 22 p0330 N79-16039
- DISEASES**  
Applying NASA remote sensing data to geologically related regional planning problems in Tennessee  
[E79-10095] 22 p0339 N79-17289
- DISPLACEMENT**  
Variable-displacement spark-ignition engine  
[SAND-77-8299] 21 p0172 N79-10435
- DISPLACEMENT MEASUREMENT**  
Study of acoustic and microseismic emissions associated with a hydraulic fracture --- geothermal energy utilization  
21 p0076 A79-14744
- DIURNAL VARIATIONS**  
Selection of method for calculating the parameters of wind and solar power station storage facilities  
21 p0054 A79-13293  
Selective covers for natural cooling devices --- in space  
22 p0272 A79-25522
- DIVERTERS**  
Magnetic divertors --- in large tokamak plasma confinement experiments  
21 p0078 A79-14781
- DOCUMENTATION**  
How to tap NASA developed technology  
21 p0164 A79-19896
- DOMESTIC ENERGY**  
Design considerations for an in situ gasification test of eastern bituminous coals  
21 p0005 A79-10049  
Operation of the Ft. Lewis, Washington Solvent Refined Coal/SRC/ Pilot Plant in the SRC I and SRC II processing modes  
21 p0006 A79-10054  
Can solar energy contribute significantly to the solution of the world's energy famine  
21 p0019 A79-10155  
The application of photovoltaic roof shingles to residential and commercial buildings  
21 p0020 A79-10170  
Design and operating experience on the U.S. Department of Energy Experimental Mod-0 100 kW Wind Turbine  
21 p0028 A79-10234  
Experimental demonstration of the Diffuser Augmented Wind Turbine concept  
21 p0029 A79-10238  
ERDA fuel cell programs  
21 p0039 A79-11814  
Energy efficiency in the transport sector  
21 p0054 A79-13574  
Design of a low-energy house in Denmark heated by a combination of solar and wind energy  
21 p0058 A79-13652  
Vacation homes near the sea with solar and wind energy utilization - Research done at the Technical University of Hannover: Architectural considerations  
21 p0058 A79-13653  
Total energy systems --- domestic solar and windpowered facilities  
21 p0058 A79-13654  
Passive solar heating and cooling  
[AIAA PAPER 78-1756] 21 p0060 A79-13857  
The economic performance of passive solar heating - A preliminary analysis --- thermal storage wall for family home design  
[AIAA PAPER 78-1761] 21 p0061 A79-13862  
Future solar total energy markets for the U.S. industrial sector  
[AIAA PAPER 78-1773] 21 p0062 A79-13870  
Solar and wind energy applications in Hawaii  
21 p0066 A79-14265  
Alternative energy for domestic hot water - Wind or solar  
21 p0067 A79-14292  
Exploring future energy options - An economic analysis  
21 p0068 A79-14324  
The National Program for Solar Energy  
21 p0072 A79-14688  
Residential energy design  
21 p0073 A79-14694  
Heat pumps without supplemental heat  
21 p0073 A79-14695  
Quantification of energy resource consumption  
21 p0073 A79-14701  
Passive solar design --- for domestic heating and cooling systems  
21 p0074 A79-14720

## DOMESTIC ENERGY CONTD

## SUBJECT INDEX

- Investigation of the optimal use of geothermal waters for the heating of several types of dwelling in various European climates 21 p0075 A79-14739
- Preliminary results of the new geothermal domestic heating system at Creil 21 p0075 A79-14740
- A challenging role for the assurance sciences --- in energy conversion technology 21 p0086 A79-15396
- A low cost approach to performance monitoring for the evaluation of a solar domestic hot water system 21 p0088 A79-15842
- Residential and commercial thermal storage --- for solar heating and cooling systems 21 p0090 A79-15865
- Geothermal energy from a utility perspective --- Imperial Valley of Southern California 21 p0091 A79-15880
- Storage as an energy strategy for utilities 21 p0093 A79-15891
- Status of photovoltaic systems and applications 21 p0095 A79-15907
- Time, technology and capital - Do we have enough to solve the energy crisis 21 p0097 A79-16100
- Net energy analysis and environmental aspects for solar tower central receiver systems. I - Methodology 21 p0097 A79-16101
- A multivariate-utility approach for selection of energy sources 21 p0098 A79-16120
- A comparative analysis of three of ERDA's major R & D programs 21 p0099 A79-16121
- An overview of the U.S. OTEC development program 21 p0100 A79-16247
- Controls for residential solar heating 21 p0101 A79-16418
- Solar controls and control modifications - New century town solar homes, Vernon Hills, IL 21 p0102 A79-16419
- Inexpensive solar energy utilization in human settlements 21 p0104 A79-16470
- Solar Thermal Electric Program 21 p0112 A79-16730
- The status of solar energy --- for domestic water heating and thermal electric power generation 21 p0115 A79-17219
- A solar energy system with a dual-source heat pump and long-term storage 21 p0119 A79-17312
- Economic use of materials in the design of solar water-heating collector plates of the pipe and fin type 21 p0129 A79-17396
- Comparison between simulation and experiment of solar heating 21 p0137 A79-17461
- Design, operation and performance of the BBC Solar House 21 p0137 A79-17462
- Solar heating performance of the Toshiba Solar House No. 1 21 p0137 A79-17465
- Conceptual development of a solar town in Iran 21 p0138 A79-17469
- Some experimental investigations on solar space heating in Korea 21 p0138 A79-17470
- Design of a low-energy house in Denmark heated by a combination of solar and wind energy 21 p0138 A79-17471
- Heat tube, a universal electrical solar heat equipment for building, community and agricultural purposes 21 p0138 A79-17473
- Heat transfer analysis of flat plate type domestic solar water heater 21 p0140 A79-17489
- Optimum insulation with internal and solar heat gains 21 p0140 A79-17490
- Periodic heating/cooling by solar radiation --- through concrete slab buildings 21 p0140 A79-17491
- Solar heating for a novel dwelling independent of servicing networks 21 p0140 A79-17492
- A summary of R&D programs --- for coal utilization 21 p0146 A79-17639
- Performance evaluation of the New Mexico State University Solar House [ASME PAPER 78-WA/SOL-8] 21 p0163 A79-19840
- Accelerating the commercialization on new technologies --- free market operation of federal alternate energy sources programs [ASME PAPER 78-WA/TS-4] 21 p0164 A79-19849
- Investigations of solar heat production for household heating in Turkey 22 p0253 A79-22265
- Solar water heaters for a cold climate 22 p0254 A79-22325
- Solar energy and heat insulation --- materials for residential buildings 22 p0268 A79-24321
- Solar storage unit with built-in oil-gas boiler 22 p0268 A79-24322
- What and where - Solar active systems or energy conservation in buildings 22 p0275 A79-25927
- Passive solar heating of buildings 22 p0275 A79-25928
- CCMS solar energy pilot study reporting format - The zero energy house in Denmark 22 p0277 A79-25940
- Photovoltaic power systems for rural areas of developing countries 22 p0278 A79-26131
- The Tritherm test house --- solar heating experiment 22 p0290 A79-27723
- Economic feasibility of solar water and space heating 22 p0292 A79-27899
- Solar thermal electrical power plants for Iran 22 p0295 A79-28352
- Pressure measurements on wind tunnel models of the Aylesbury experimental house 22 p0300 A79-29372
- The impact of alternate energy resources on the future supply of electric power [IEEE PAPER P 78 672-8] 22 p0304 A79-29939
- Solar photovoltaic power for residential use [ASME PAPER 79-SOL-11] 22 p0308 A79-30546
- Measured and predicted performance of solar domestic water heaters 22 p0319 A79-31422
- Allowable costs for alternative domestic heating systems using utility supplied electricity for backup or charging energy 22 p0319 A79-31428
- Domestic water preheating using solar energy 22 p0321 A79-31437
- Economic design of a solar domestic water heating system 22 p0321 A79-31438
- Solutions to energy conservation in northern climates 22 p0321 A79-31443
- Passive solar heating - Results from two Saskatchewan residences 22 p0322 A79-31444
- Integration of a passive and active solar heated, low density, multiple dwelling with atrium 22 p0322 A79-31446
- First year performance data and lessons learned in the NEC 14 house solar demonstration program 22 p0323 A79-31453
- Alternate energy installations on the Jordan College Campus 22 p0323 A79-31454
- Determination of the potential for solar retrofitting in Edmonton --- pilot systems for single family dwellings 22 p0323 A79-31456
- Solar heating of domestic hot water at the Confederation Heights Cafeteria 22 p0323 A79-31457
- P.E.I. solar-assisted domestic water heat project 22 p0323 A79-31458
- Preliminary design package for solar heating and hot water system [NASA-CR-150619] 21 p0173 A79-10520

## SUBJECT INDEX

## EARTH CRUST

Solar heating and cooling demonstration project  
 summaries [DOE/CS-0009] 21 p0186 A79-11503  
 Energy use in Japan and the United States [BNL-23101] 21 p0221 A79-14578  
 Passive thermosyphon solar heating and cooling module with supplementary heating [NASA-CR-150849] 21 p0229 A79-15402  
**DOMESTIC SATELLITE COMMUNICATIONS SYSTEMS**  
 Space will be the next big construction site 22 p0268 A79-24450  
**DOPED CRYSTALS**  
 Preparation and properties of pure and tin doped indium oxide selective coatings 21 p0127 A79-17381  
 New models of solar cells and prospects for their optimization 21 p0166 A79-20346  
**DOWNWASH**  
 Supersonic flow in an MHD channel with a downwash flow at the inlet 21 p0085 A79-15342  
**DRAG REDUCTION**  
 Drag reduction by cooling in hydrogen fueled aircraft 21 p0165 A79-20084  
 Winglets give USAF KC-135 new look in life 22 p0265 A79-23975  
**DRAINAGE**  
 Source assessment: Water pollutants from coal storage areas [PB-285420/6] 21 p0223 A79-14635  
**DRIFT RATE**  
 Stability criteria for current-driven drift wave eigenmodes --- in tokamaks 22 p0269 A79-24813  
**DROP SIZE**  
 Drop formation, evaporation modelling and environmental assessment of JP-4 fuel jettisoned from aircraft [AIAA PAPER 79-0186] 21 p0157 A79-19585  
**DRY HEAT**  
 Mining earth's heat - Hot dry rock geothermal energy 22 p0258 A79-23280  
 Hot dry rock - A new potential for energy 22 p0265 A79-23832  
 Thermal conductivity of crystalline rocks associated with energy extraction for hot dry rock geothermal systems 22 p0304 A79-30123  
 Hot dry rock energy project [LA-UR-77-2744] 21 p0175 A79-10540  
**DRYING**  
 Upgrading lignite by the Koppelman process 21 p0146 A79-17641  
**DRYING APPARATUS**  
 25 kilowatt photovoltaic powered irrigation and grain drying experiment 21 p0143 A79-17519  
 Solid desiccant air conditioning with silica gel using solar energy 21 p0181 A79-11464  
**DUAL SPIN SPACECRAFT**  
 Spatial oscillations of a solid body carrying a low-power flywheel motor --- dual spin spacecraft motion control 21 p0148 A79-17792  
**DUCTED FAN ENGINES**  
 Review of the Rhein-Flugzeugbau Wankel powered aircraft program --- ducted fan engines 22 p0329 A79-15966  
**DUCTED FLOW**  
 Velocity, temperature, and electrical conductivity profiles in hydrogen-oxygen MHD duct flows 22 p0279 A79-26184  
 Thermoelectric magnetohydrodynamics 22 p0312 A79-31098  
 Two-dimensional analyses related to wave-energy extraction by submerged resonant ducts 22 p0312 A79-31099  
 MHD generator duct flow with cross stream dependent fluid properties 22 p0336 A79-16668  
**DUST**  
 Effect of dust on flat plate collectors 21 p0129 A79-17399

**DUST COLLECTORS**  
 On the dynamics of electrostatically precipitated fly ash [ASME PAPER 78-WA/PU-3] 21 p0160 A79-19787  
**DUST STORMS**  
 Effect of dust on flat plate collectors 21 p0129 A79-17399  
**DYES**  
 Merocyanine organic solar cells 21 p0165 A79-20216  
**DYNAMIC CHARACTERISTICS**  
 New design verification aspects of large flexible solar arrays [IAP PAPER 78-217] 21 p0035 A79-11298  
 On the dynamics of electrostatically precipitated fly ash [ASME PAPER 78-WA/PU-3] 21 p0160 A79-19787  
 Dynamic characteristics of a free-piston diesel engine combined with a MHD generator 22 p0258 A79-23137  
**DYNAMIC CONTROL**  
 Controlling the radiant flux of a high-temperature solar energy conversion system over two parameters 22 p0296 A79-28669  
**DYNAMIC LOADS**  
 Fatigue impact on Mod-1 wind turbine design 22 p0240 A79-20827  
 Evaluation of MOSTAS computer code for predicting dynamic loads in two-bladed wind turbines [AIAA 79-0733] 22 p0298 A79-29007  
 Evaluation of MOSTAS computer code for predicting dynamic loads in two bladed wind turbines [NASA-TN-79101] 22 p0368 A79-21549  
**DYNAMIC MODELS**  
 Dynamic model of an industrial plant manufacturing a variety of products 21 p0051 A79-12957  
 A comparative analysis of three of ERDA's major R & D programs 21 p0099 A79-16121  
 Gasification Combined Cycle Test Facility at Pekin, Illinois 21 p0145 A79-17632  
 Modelling and control of a fluidized bed gasifier 22 p0332 A79-16345  
 The Brookhaven buildings energy conservation optimization model [BNL-50828] 22 p0370 A79-21564  
**DYNAMIC RESPONSE**  
 Dynamic response of a wind turbine system and its effect on performance 21 p0067 A79-14293  
 Dynamic response of a novel solar water heater --- collector using low-boiling liquid between flat plates 21 p0140 A79-17488  
 Comparison of transient heat transfer models for flat plate collectors 22 p0242 A79-21168  
 Nonlinear dynamic response of wind turbine rotors [NASA-TN-78324] 21 p0195 A79-12542  
**DYNAMIC STRUCTURAL ANALYSIS**  
 Evaluation of MOSTAS computer code for predicting dynamic loads in two-bladed wind turbines [AIAA 79-0733] 22 p0298 A79-29007  
**DYNAMIC TESTS**  
 Air bearing development for a GM automotive gas turbine [SAE PAPER 790107] 22 p0314 A79-31355  
**DYNAMOMETERS**  
 Performance characteristics of automotive engines in the United States. First series, report no. 19: 1975 Ford Windsor 351 CID (5.7 liters), 2V [PB-286300/9] 21 p0228 A79-15314

## E

**EARTH ALBEDO**  
 Irradiances on inclined surfaces --- from solar and sky radiation and earth albedo 21 p0055 A79-13624  
**EARTH ATMOSPHERE**  
 Diffuse solar radiation on a horizontal surface for a clear sky 22 p0242 A79-21167  
**EARTH CRUST**  
 Mining earth's heat - Hot dry rock geothermal energy 22 p0258 A79-23280

# EARTH ENVIRONMENT

# SUBJECT INDEX

- Continental geotherms during the Archean --- heat production in ancient earth crust  
22 p0269 A79-24620
- EARTH ENVIRONMENT**  
Optics in adverse environments; Proceedings of the Seminar, San Diego, Calif., August 25, 26, 1977  
21 p0044 A79-12037
- EARTH ORBITS**  
Enhanced solar energy options using earth-orbiting mirrors  
21 p0019 A79-10162  
Orbiting mirrors for terrestrial energy supply  
21 p0108 A79-16605
- EARTH RESOURCES**  
Comparison of shale oils from different sources produced by controlled-state retort  
21 p0005 A79-10047  
Permeability enhancement using explosive techniques --- georesources recovery techniques  
21 p0005 A79-10048  
Toward a materials-conservation ethic  
21 p0167 A79-20438  
Future programs and prospects for resource exploration from space by the year 2000 [AAS PAPER 78-182]  
22 p0243 A79-21275  
Climatic change in connection with energy growth --- resource consumption effects  
22 p0284 A79-26623  
Outlook for world oil into the 21st century with emphasis on the period to 1990 [EPRI-BA-745]  
21 p0181 A79-11454  
A synoptic description of coal basins via image processing [NASA-CR-157970]  
21 p0204 A79-13474  
Identification of wood energy resources in central Michigan [NASA-CR-158130]  
22 p0347 A79-18424  
The world balance for energy needs in view of year 2000: Development of the problem and areas involved, part 2 [BLL-RISLEY-TR-3395-(9091.9P)]  
22 p0347 A79-18442
- EARTH SURFACE**  
Fundamentals of mathematical modeling of solar-radiation regime energy structure  
21 p0166 A79-20352  
Surtrace - An airborne geochemical system --- for earth surface micro-layer exploration  
22 p0255 A79-22557
- ECOLOGY**  
Assessing environmental costs of energy procurement  
21 p0071 A79-14682  
Reservoir ecosystems and western coal development in the upper Missouri River Basin [PB-287363/6]  
22 p0339 A79-17309  
Ecological effects of coal-fired steam-electric generating stations  
22 p0346 A79-18358  
A biologist's manual for the evaluation of impacts of coal-fired power plants on fish, wildlife and their habitats [PB-291330/9]  
22 p0373 A79-21679
- ECONOMETRICS**  
Econometric analysis of concentrators for solar cells  
21 p0149 A79-18017
- ECONOMIC ANALYSIS**  
A method for the comparative economic assessment of storage systems  
21 p0013 A79-10111  
Considerations for MHD power generation development  
21 p0016 A79-10136  
Advanced wind furnace systems for residential and agricultural heating and electrical supply applications  
21 p0028 A79-10237  
Economic methodology for solar power-generating systems  
21 p0030 A79-10251  
The economic performance of passive solar heating - A preliminary analysis --- thermal storage wall for family home design [AIAA PAPER 78-1761]  
21 p0061 A79-13862  
Pennies a day - Financing early deployment of photovoltaic utility applications through a user subsidy [AIAA PAPER 78-1767]  
21 p0061 A79-13866
- A standard procedure of economic evaluation for energy-producing and pollution-abatement operations  
21 p0064 A79-14109  
Exploring future energy options - An economic analysis  
21 p0068 A79-14324  
Economic optimization of heatpump assisted solar heating in Illinois  
21 p0072 A79-14691  
Comparison of nuclear and coal power plants using Net Energy Analysis  
21 p0073 A79-14692  
Heat pumps without supplemental heat  
21 p0073 A79-14695  
Low head power generation with bulb turbines --- hydroelectric installations  
21 p0074 A79-14705  
Economics and net energy analysis - Is a new analytical technique needed for energy decision making  
21 p0074 A79-14706  
Basic technical and economical aspects of the use of solar energy for pumping irrigation water  
21 p0076 A79-14763  
A challenging role for the assurance sciences --- in energy conversion technology  
21 p0086 A79-15396  
Design of active solar heating systems  
21 p0090 A79-15860  
Theory of solar assisted heat pumps  
21 p0090 A79-15864  
An introduction to ocean thermal energy conversion /OTEC/ power plants  
21 p0091 A79-15869  
Materials and economics of energy systems  
21 p0095 A79-15911  
A methodological note on the evaluation of new technologies - The case of coal gasification  
21 p0099 A79-16122  
An economist looks at solar energy - The government's role  
21 p0099 A79-16132  
Current solar applications and economics  
21 p0099 A79-16134  
Economic opportunities of space enterprise in the next decades  
21 p0100 A79-16137  
Controls for residential solar heating  
21 p0101 A79-16418  
Solar collectors. II - Recent developments and future performance data and economic analysis  
21 p0103 A79-16456  
Energy conservation by means of recycling  
21 p0112 A79-16735  
The impact of advanced technology on the future electric energy supply problem  
21 p0112 A79-16736  
Input-output method applied to energy planning  
21 p0112 A79-16737  
Design considerations for solar power satellites  
21 p0113 A79-16738  
Energy economics - A research analysis --- considering OPEC Cartel impact  
21 p0115 A79-17222  
Energy and input-output analysis --- for predicting impact on U.S. economy  
21 p0115 A79-17223  
Energy balances as a means for the evaluation of solar energy in developing countries  
21 p0118 A79-17290  
Economic evaluation and optimization of solar heating systems  
21 p0118 A79-17293  
Impacts of the National Energy Plan on solar economics [CONP-771203-6]  
21 p0118 A79-17294  
Optimal profile of solar energy collectors  
21 p0130 A79-17408  
Alternative forms of energy transmission from OTEC plants  
21 p0141 A79-17505  
Technical and economic feasibility of making fertilizer from wind energy, water, and air  
21 p0142 A79-17512  
OTEC in Europe --- economic aspects of Ocean Thermal Energy Conversion  
21 p0152 A79-18109

# SUBJECT INDEX

# ECONOMIC IMPACT

Review of optimization and economic evaluation of potential tidal power developments in the Bay of Fundy 21 p0152 A79-18111

The economics of Fundy tidal power 21 p0152 A79-18112

Energy storage - Economics and fuel conservation 21 p0153 A79-18464

Financial/management scenarios for a satellite power system program [AAS PAPER 78-144] 22 p0243 A79-21259

Economic prospects for the application of new electric energy storage devices 22 p0246 A79-21490

The economics of geothermal energy development at the regional level 22 p0256 A79-22756

An economic analysis of synthetic fuels production from eastern oil shale via hydroretort processing 22 p0264 A79-23780

Economic feasibility of solar water and space heating 22 p0292 A79-27899

Solar thermal electrical power plants for Iran 22 p0295 A79-28352

The energy and resource implications associated with the widespread use of electric vehicles 22 p0301 A79-29489

The fleet operator's viewpoint --- on prototype electric bus development 22 p0302 A79-29495

A flywheel energy storage and conversion system for solar photovoltaic applications [ASME PAPER 79-SOL-1] 22 p0307 A79-30539

The economics of electric power generation from wind energy 22 p0310 A79-30998

An economical approach to space power systems 21 p0170 A79-10139

Energy: The new economic development wildcard [PB-282494/4] 21 p0177 A79-10564

Economics of Texaco gasification: Combined cycle systems. Economic studies of coal gasification combined cycle systems for electric power generation [EPRI-AP-753] 21 p0185 A79-11498

Specific heat variations in oil energy storage media and their economic implications [SAND-78-8672] 21 p0189 A79-11537

Energy and the economy [EPRI-EA-620-VOL-1] 21 p0189 A79-11539

Application of solar technology to today's energy needs, volume 1 [PB-283770/6] 21 p0190 A79-11548

Methanol from wood waste: A technical and economic study [PPL-12] 21 p0194 A79-12239

Vehicle Design Evaluation Program (VDEP). A computer program for weight sizing, economic, performance and mission analysis of fuel-conservative aircraft, multibodied aircraft and large cargo aircraft using both JP and alternative fuels [NASA-CR-145070] 21 p0200 A79-13026

Energy systems studies program [BNL-50822] 21 p0209 A79-13526

Three modes of energy cost analysis: Then-current dollars, base-year dollars, and perpetual-constant dollars [ORAU/IEA(N)-78-10] 21 p0209 A79-13531

Proposed standby gasoline rationing plan. Economic and regulatory analysis draft [DOE/EBA-0009] 21 p0214 A79-13934

Analytical methods 21 p0218 A79-14531

Preliminary economic analysis of Solar Irrigation Systems (SIS) for selected locations [SAND-77-1403] 21 p0220 A79-14566

Engineering and economic analysis of waste to energy systems [PB-285797/7] 21 p0224 A79-14946

Satellite Power Systems (SPS) concept definition study. Volume 7: SPS program plan and economic analysis [NASA-CR-158068] 21 p0225 A79-15141

Satellite power systems (SPS) concept definition study. Volume 7: SPS program plan and economic analysis, appendixes [NASA-CR-150702] 21 p0225 A79-15142

Energy and economic analysis of industrial process heat recovery with heat pumps 22 p0331 A79-16210

Local perceptions of energy development: The case of the Kaiparowits Plateau [PB-287314/9] 22 p0335 A79-16380

Solar heating of buildings: Design optimization and economic analysis 22 p0353 A79-19439

**ECONOMIC DEVELOPMENT**

Uncoupling of economic growth and energy consumption - A new strategy of energy politics or only a new slogan 22 p0310 A79-30997

Energy needs, uses, and resources in developing countries [BNL-50784] 21 p0185 A79-11500

**ECONOMIC FACTORS**

Performance and economic risk evaluation of dispersed solar thermal power systems by Monte Carlo simulation 21 p0020 A79-10163

Residential energy design 21 p0073 A79-14694

Factors influencing solar energy commercialization 21 p0093 A79-15897

Time, technology and capital - Do we have enough to solve the energy crisis 21 p0097 A79-16100

The economics and policy of alternative energy sources - A review 21 p0103 A79-16454

Technical and economic aspects of open-cycle MHD power plants 21 p0105 A79-16482

Factors affecting market initiation of solar total energy 21 p0112 A79-16732

Economic evaluation of the ATC/Wellman incandescent two-stage low Btu coal gas producer 21 p0146 A79-17640

Gasification of coal with high-temperature reactor heat - Investigations concerning the market and the economics 22 p0264 A79-23828

Space reflector technology and its system implications [AIAA PAPER 79-0545] 22 p0273 A79-25852

Economics of fuel gas from coal: An update including the British Gas Corporation's slagging gasifier [EPRI-AP-782] 21 p0180 A79-11238

Energy situation in the Mid-Atlantic region [BNL-50703] 21 p0188 A79-11528

Bureau of Mines research 1977. A summary of significant results in mining, metallurgy, and mineral economics [PB-284743/2] 21 p0217 A79-14521

Statement of Doctor Krafft A. Ehrlicke, President, Space Global, La Jolla, California 21 p0224 A79-15108

Assessment of the potential of solar thermal small power systems in small utilities [NASA-CR-158093] 22 p0335 A79-16377

**ECONOMIC IMPACT**

Thermionic power plant design point selection - The economic impact 21 p0025 A79-10214

Macro-energy model - Impact of public policy on technological development 21 p0113 A79-16741

Impacts of the National Energy Plan on solar economics [CONP-771203-6] 21 p0118 A79-17294

Costs and impacts of financial incentives for solar energy systems 21 p0119 A79-17296

Synthetic oil from coal - The economic impact of five alternatives for making hydrogen from coal and steam 22 p0262 A79-23719

The impact of alternate energy resources on the future supply of electric power [IEEE PAPER P 78 672-8] 22 p0304 A79-29939

National coal utilization assessment: An integrated assessment of increased coal use in the midwest: Impacts and constraints, volume 1 [ANL/AA-11-VOL-1-DRAFT] 21 p0174 A79-10537

- Energy scenarios: Supplementary studies  
[WP-23292] 21 p0211 N79-13543
- A detailed analysis of the impact of onsite equipment on utility costs --- marginal costs of providing backup power for solar energy systems  
21 p0218 N79-14535
- The national energy plan: Options under assumptions of national security threat --- economic impact procurement policy, and resources management  
[H-PRINT-95-48] 21 p0228 N79-15398
- Energy and the economy: The economic impact of alternative energy supply-demand assumptions  
[H-PRINT-95-51] 22 p0333 N79-16352
- Economic impacts of a transition to higher oil prices --- estimation and budget allocations  
[BNL-50871] 22 p0364 N79-20927
- ECONOMICS**
- The economics of solar heating and cooling - A cautious view  
21 p0119 A79-17297
- Economics of fusion research  
[COO-4181-] 21 p0193 N79-11890
- ECOSYSTEMS**
- Energy technologies and natural environments - The search for compatibility  
21 p0074 A79-14721
- Solar energy, water, and industrial systems in arid lands: Technological overview and annotated bibliography  
[PB-285129/3] 21 p0211 N79-13549
- Impact prediction manual for geothermal development  
[BNL-128/2] 22 p0349 N79-18462
- EDDY CURRENTS**
- On the use of eddy-current couplings in wind-driven synchronous machines  
21 p0113 A79-16742
- Differential pressure measurements in high temperature environments  
21 p0144 A79-17599
- EDUCATION**
- Industrial aspects in solar energy instruction  
22 p0254 A79-22274
- Energy education training: Feasibility study  
[PB-285910/6] 21 p0230 N79-15428
- EFFLUENTS**
- The feasibility of constructing a photoelectric unit utilizing effluent heat  
21 p0125 A79-17358
- Emissions from pressurized fluidized-bed combustion processes  
22 p0261 A79-23640
- Status of bioscreening of emissions and effluents from energy technologies  
22 p0346 N79-18353
- EGYPT**
- Possibilities for solar energy utilization in Egypt  
21 p0102 A79-16453
- EJECTORS**
- Ejector augmentation of the air supply in a compressed air energy storage plant  
21 p0013 A79-10109
- Equations of a conduction MHD ejector  
22 p0298 A79-29289
- ELECTRIC ARCS**
- Mechanism of erosion of metal electrodes of the channel of a MHD generator  
22 p0306 A79-30391
- Axial field limitations in MHD generators  
[PE-2341-8] 22 p0362 N79-20512
- ELECTRIC AUTOMOBILES**
- The propulsion of vehicles by a flywheel  
21 p0031 A79-10452
- Electric automobiles - Yes  
21 p0046 A79-12265
- Partial energy supply to electric vehicles through solar cell system  
21 p0077 A79-14767
- Flywheels for vehicles --- auxiliary power in electric automobiles  
21 p0092 A79-15885
- Electric vehicles challenge battery technology  
21 p0093 A79-15892
- Composite material flywheel for the electric-powered passenger vehicle  
22 p0240 A79-20842
- Flywheel energy accumulators for road vehicles  
22 p0241 A79-20845
- Electric vehicle progress in the U.S. - Where to  
22 p0269 A79-24611
- Electricity - An indigenous transport fuel  
22 p0292 A79-27898
- EPRI/TVA pilot electric vehicle demonstration program  
[SAE PAPER 790110] 22 p0314 A79-31357
- The London Electric Delivery Van Assessment Scheme  
[SAE PAPER 790111] 22 p0314 A79-31358
- Electric vehicle battery development  
[SAE PAPER 790158] 22 p0314 A79-31363
- Mechanically rechargeable, metal-air batteries for automotive propulsion  
[UCRL-81178] 21 p0189 N79-11538
- Impact of electric passenger automobiles on utility system loads, 1985 - 2000  
[EPRI-EA-623] 21 p0203 N79-13281
- ELECTRIC BATTERIES**
- The secondary lithium electrode in non-aqueous electrolytes - Some problems, some solutions  
21 p0041 A79-11838
- Progress in batteries and solar cells. Volume 1 --- Book  
21 p0148 A79-17989
- Energy storage by the use of high temperature electrochemical systems  
21 p0148 A79-17992
- Development of a 1 kW fuel cell aggregate with acid electrolyte  
21 p0148 A79-17994
- A study of positive electrode materials for batteries operating in a halide-aluminate medium  
22 p0245 A79-21480
- Effect of electrolyte impurity on the electrochemical performance of the lead/tetrafluoroboric acid/lead dioxide cell  
22 p0246 A79-21485
- Energy storage requirements for spacecraft  
22 p0246 A79-21486
- Differential scanning calorimetry studies of possible explosion-causing mixtures in Li/SO<sub>2</sub> cells  
22 p0246 A79-21487
- Discharge characteristics of a soluble iron-titanium battery system  
22 p0286 A79-26996
- On future carburants. II --- alternative fuels from alcohols and hydrogen  
22 p0296 A79-28439
- EPRI/TVA pilot electric vehicle demonstration program  
[SAE PAPER 790110] 22 p0314 A79-31357
- Technology status: Batteries and fuel cells  
21 p0170 N79-10132
- Battery workshop  
21 p0170 N79-10143
- Battery and electrochemical systems program summary, FY 1977  
[DOE/ET-0014] 21 p0176 N79-10546
- Supply of reactants for Redox bulk energy storage systems  
[NASA-TM-78995] 21 p0183 N79-11479
- Battery Energy Storage Test (BEST) Facility. Phenomenological cell modeling: A tool for planning and analyzing battery testing at the BEST facility  
[COO-2857-1] 21 p0184 N79-11490
- Electric batteries. A bibliography  
[TID-3361] 21 p0184 N79-11491
- Sodium-antimony trichloride battery development program for load leveling  
[EPRI-EH-751] 21 p0186 N79-11501
- A state of charge monitor for sealed lead-acid cells  
[ATR-78(8114)-2] 21 p0220 N79-14558
- Design and cost study of a nickel-iron oxide battery for electric vehicles. Volume 2: Public report  
[ANL-X-3723-VOL-1] 21 p0222 N79-14579
- Development of high temperature fuel cell battery  
[BNFT-PB-T-77-17] 22 p0342 N79-17344
- The optimum voltage for batteries used in standby lighting systems  
[BLL-BTS-11512] 22 p0347 N79-18439
- This film battery/fuel cell power generating system  
[CONS/1197-9] 22 p0369 N79-21556
- The 1977 Goddard Space Flight Center Battery Workshop  
[NASA-CP-2041] 22 p0370 N79-21565



# SUBJECT INDEX

# ELECTRIC GENERATORS

- Synchronous meteorological and geostationary operational environmental satellites battery and power system design 22 p0370 N79-21571
- NASA's OAST program: An overview 22 p0370 N79-21574
- Effort of the Jet Propulsion Laboratory 22 p0370 N79-21575
- Levis Research Center program 22 p0370 N79-21576
- Accelerated test program 22 p0370 N79-21577
- ELECTRIC CELLS**
- Heat transfer in phosphoric acid fuel cell stacks 21 p0010 A79-10091
- ELECTRIC COILS**
- Mathematics of coiling in cylindrical electrochemical cells - The theory of a spiral bounded by two circles and its application to the spiral-wound nickel-cadmium cell 22 p0246 A79-21489
- ELECTRIC CONDUCTORS**
- High-current power leads for tokamak fusion reactor superconducting magnets 21 p0085 A79-15318
- ELECTRIC CONNECTORS**
- Electric power losses of current input into superconducting devices cooled by supercritical helium 22 p0235 A79-20530
- ELECTRIC CONTACTS**
- High reliability contacts for miniature thermoelectric converters 21 p0027 A79-10228
- ELECTRIC CORONA**
- Theory of the striated corona in a theta pinch 22 p0295 A79-28315
- ELECTRIC CURRENT**
- Analysis of electrolyte shunt currents in fuel cell powerplants 21 p0039 A79-11816
- Calculating the photocurrent and maximum efficiency of film p-CdTe-n-CdS photocells 21 p0166 A79-20354
- The economics of electric power generation from wind energy 22 p0310 A79-30998
- Plasma behavior near the neutral line between parallel currents --- in planar zeta pinch 22 p0324 A79-31754
- ELECTRIC DISCHARGES**
- Response of lead-acid batteries to chopper-controlled discharge --- for electric vehicles 21 p0011 A79-10097
- 'Local' breakdown criterion in highly ionized gas flow 21 p0049 A79-12683
- ELECTRIC ENERGY STORAGE**
- Electrochemical engines for power generation and load-leveling at sites for underground coal conversion 21 p0005 A79-10051
- 100MWh zinc-chlorine peak-shaving battery plants 21 p0011 A79-10096
- Calcium/iron sulfide secondary cells 21 p0041 A79-11835
- Conductor for IASL 10-MWhr superconducting energy storage coil 21 p0085 A79-15309
- Compatibility of direct energy storage devices with ac. processing power system components 21 p0111 A79-16728
- Controlling a wind generator for increased efficiency 21 p0113 A79-16743
- Energy storage - Economics and fuel conservation 21 p0153 A79-18464
- Superconducting energy storage magnets 22 p0236 A79-20537
- Composite material flywheels for energy storage on electricity supply systems 22 p0241 A79-20852
- Economic prospects for the application of new electric energy storage devices 22 p0246 A79-21490
- Prospects for improvements in lead-acid batteries --- for electric vehicles 22 p0300 A79-29488
- Homopolar generator energy storage for fusion reactors 22 p0304 A79-29942
- Unique aspects of terrestrial photovoltaic system design [ASME PAPER 79-SOL-14] 22 p0308 A79-30548
- Region at the crossroads: The Pacific Northwest searches for new sources of electric energy [PB-284691/3] 21 p0222 N79-14583
- ELECTRIC EQUIPMENT TESTS**
- Field testing of 5-kW commercial wind generator with an automatic load-matching device for utilizing its output 21 p0143 A79-17515
- Photovoltaic tests and applications project [NASA-TN-79018] 22 p0342 N79-17336
- ELECTRIC FIELDS**
- Investigation of the Hall effect in a discharge with a rotational electric field 22 p0246 A79-21532
- Plasma behavior near the neutral line between parallel currents --- in planar zeta pinch 22 p0324 A79-31754
- Axial field limitations in MHD generators [PE-2341-8] 22 p0362 N79-20512
- ELECTRIC GENERATORS**
- A new power cycle that combines power generation with energy storage 21 p0004 A79-10040
- Electrochemical engines for power generation and load-leveling at sites for underground coal conversion 21 p0005 A79-10051
- Potential of the Stirling engine for stationary power applications in the 500-2000 HP range 21 p0025 A79-10211
- There is a lot of energy in digester gas ... use it --- in municipal waste water plants 21 p0035 A79-11448
- Small solar power plant with a Freon turbine 21 p0057 A79-13642
- Low-cost concept for energy supply from the wind 21 p0058 A79-13651
- Wave driven power generating system 21 p0059 A79-13657
- Projecting energy resource utilization - The geothermal case 21 p0068 A79-14321
- Solar engines - The thermal wheel and beyond 21 p0095 A79-15909
- Solar electricity production 21 p0104 A79-16467
- The Netherlands experimental vertical axis wind turbine 21 p0114 A79-17120
- The Campbell Chinese Type Windmill 21 p0142 A79-17510
- Wind generation of electricity for a novel dwelling independent of servicing networks 21 p0142 A79-17513
- Vertical axis wind turbine status 21 p0143 A79-17516
- A technique for longitudinal correlation of wind data - Theory and its application to siting of wind power plants 21 p0143 A79-17518
- Wave power electric generation study in Japan --- large scale buoy facility 21 p0151 A79-18107
- A cavity receiver design for solar heated gas turbine generating systems [ONERA, TP NO. 1978-137] 21 p0155 A79-18560
- Selection of thermal operating regimes for fuel cell reactor-condenser systems 21 p0165 A79-20342
- Gas turbine with waste heat utilization - Low investment costs and high fuel use efficiency 21 p0168 A79-20448
- MIT-DOE program to demonstrate an advanced superconducting generator 22 p0236 A79-20549
- Electrochemical use of biomass 22 p0254 A79-22273
- On the dynamics of wave-power devices 22 p0269 A79-24539
- Photovoltaic power systems for rural areas of developing countries 22 p0278 A79-26131

## ELECTRIC HYBRID VEHICLES

## SUBJECT INDEX

- Solar power satellite 22 p0287 A79-27375
- A wave activated electric generator --- waterwave energy conversion 22 p0288 A79-27389
- Development and application of techniques to evaluate cogeneration impacts --- simultaneous electric energy and process heat production in electric power plants 22 p0303 A79-29795
- The combined reheat gas turbine/steam turbine cycle. I - A critical analysis of the combined reheat gas turbine/steam turbine cycle [ASME PAPER 79-GT-7] 22 p0306 A79-30505
- The combined reheat gas turbine/steam turbine cycle. II - The LM 5000 gas generator applied to the combined reheat gas turbine/steam turbine cycle [ASME PAPER 79-GT-8] 22 p0306 A79-30506
- Photovoltaic electric power generation from a utility perspective [ASME PAPER 79-SOL-18] 22 p0309 A79-30552
- The economics of electric power generation from wind energy 22 p0310 A79-30998
- The utilization of LH2 and LNG cold for generation of electric power by a cryogenic-type Stirling engine 22 p0311 A79-31020
- Future Orbital Power Systems Technology Requirements [NASA-CP-2058] 21 p0169 N79-10122
- Alternative power-generation systems 21 p0169 N79-10129
- Economics of Texaco gasification: Combined cycle systems. Economic studies of coal gasification combined cycle systems for electric power generation [EPRI-AP-753] 21 p0185 N79-11498
- Definition of engineering development and research problems relating to the use of geothermal fluids for electric power generation and nonelectric heating [LBI-7025] 21 p0188 N79-11534
- Civilian applications of laser fusion [UCRL-52349] 21 p0195 N79-12439
- Optical design of a solar collector for the advanced solar thermal electric conversion/process heat program [Y/SUB-77/14261] 21 p0209 N79-13528
- Solar electric power generation, volume 2. Citations from the Engineering Index data base [NTIS/PS-78/1109/4] 21 p0212 N79-13558
- Harnessing tidal energy [PB-286671/3] 21 p0222 N79-14581
- Development of a phase-change thermal storage system using modified anhydrous sodium hydroxide for solar electric power generation [NASA-CR-159465] 22 p0354 N79-19454
- MHD power generation: Research, development and engineering [FE-2524-8] 22 p0363 N79-20517
- Thin film battery/fuel cell power generating system [CONS/1197-9] 22 p0369 N79-21556
- ELECTRIC HYBRID VEHICLES**
- Fiat Research Center hybrid vehicle prototype [SAE PAPER 790014] 22 p0313 A79-31351
- Efficiency studies about Daihatsu engine/electric hybrid system [SAE PAPER 790013] 22 p0314 A79-31352
- The Stirling engine for automotive application [SAE PAPER 790329] 22 p0315 A79-31370
- Electric automobiles. Citations from the NTIS data base [NTIS/PS-78/0880/1] 21 p0171 N79-10363
- Electric automobiles, volume 2. Citations from the engineering index data base [NTIS/PS-78/0881/9] 21 p0172 N79-10364
- Advanced secondary batteries for electric vehicle propulsion [CONF-780426-2] 21 p0186 N79-11508
- Recommended performance standards for electric and hybrid vehicles [SAM/1335-1] 21 p0195 N79-12450
- Electric and Hybrid Vehicle Act, Public Law 94-413 demonstration program objective and schedule [GPO-98-809] 22 p0351 N79-18810

## ELECTRIC MOTOR VEHICLES

- User experience with on-road electric vehicles in the U.S.A. and Canada 21 p0009 A79-10080
- A critical review and evaluation of published electric-vehicle performance data 21 p0009 A79-10081
- Pulse characteristics of sodium sulfur cells for electric vehicle propulsion 21 p0009 A79-10082
- Rapid, efficient charging of lead-acid and nickel-zinc traction cells --- for electric vehicles 21 p0009 A79-10084
- Review of industrial participation in the ANL lithium/iron sulfide battery development program --- for electric vehicles 21 p0010 A79-10086
- High performance lithium/iron disulfide cells --- for electric vehicle propulsion 21 p0010 A79-10087
- Lithium silicon - Iron sulfide load-leveling and electric vehicle batteries 21 p0010 A79-10088
- Advances in the development of lithium-aluminum/metal sulfide cells for electric-vehicle batteries 21 p0010 A79-10089
- Bipolar lithium/iron disulfide cells --- for electric vehicle propulsion 21 p0010 A79-10090
- Mechanically rechargeable, metal-air batteries for automotive propulsion 21 p0011 A79-10093
- Iron-air batteries for electric vehicles 21 p0011 A79-10094
- Response of lead-acid batteries to chopper-controlled discharge --- for electric vehicles 21 p0011 A79-10097
- Batteries for transportation and load-leveling applications 21 p0041 A79-11837
- Advanced batteries --- sodium sulfur batteries for electric motor vehicles 21 p0067 A79-14270
- Total energy and labor requirements for an electric commuter railroad 21 p0068 A79-14325
- Flywheels for vehicles --- auxiliary power in electric automobiles 21 p0092 A79-15885
- Electric vehicles challenge battery technology 21 p0093 A79-15892
- The Power Wheel - Elimination of energy-consuming drive components 21 p0112 A79-16734
- Modeling energy and power requirements of electric vehicles 21 p0153 A79-18465
- The sodium/sulfur battery - A storage battery for peak load adjustment and electric traction 21 p0165 A79-20244
- Evaluation of the effectiveness of electric power systems for transport purposes 22 p0284 A79-26723
- Superbatteries - A progress report --- for utility energy storage and electric vehicles 22 p0286 A79-27207
- International Conference on Electric Vehicle Development, London, England, May 31, June 1, 1977, Proceedings 22 p0300 A79-29487
- Prospects for improvements in lead-acid batteries --- for electric vehicles 22 p0300 A79-29488
- The energy and resource implications associated with the widespread use of electric vehicles 22 p0301 A79-29489
- Recent developments in power sources with special emphasis on alkaline batteries --- for electric vehicles 22 p0301 A79-29490
- The role of the battery electric vehicle 22 p0301 A79-29491
- Support services for electric vehicles 22 p0301 A79-29492

# SUBJECT INDEX

# ELECTRIC POWER PLANTS

- Electric vehicles - Can they be fitted into urban Britain  
22 p0301 A79-29493
- Road vehicles with combined, at least partly electrical driving systems and energy supplies  
22 p0301 A79-29494
- The fleet operator's viewpoint --- on prototype electric bus development  
22 p0302 A79-29495
- Developing electric vehicles  
22 p0302 A79-29496
- Latest developments in sponsored test programs for electric vehicles in France  
22 p0302 A79-29497
- Electric car project of the Eindhoven University of Technology  
22 p0302 A79-29498
- An electric propulsion system for a town and city bus  
22 p0302 A79-29499
- Thermal management of the lithium/metal sulfide electric vehicle  
[SAE PAPER 790161]  
22 p0315 A79-31366
- A high energy tubular battery for a 1800 kg payload electric delivery van  
[SAE PAPER 790162]  
22 p0315 A79-31367
- Electric automobiles. Citations from the NTIS data base  
[NTIS/PS-78/0880/1]  
21 p0171 A79-10363
- Electric automobiles, volume 2. Citations from the engineering index data base  
[NTIS/PS-78/0881/9]  
21 p0172 A79-10364
- Recommended performance standards for electric and hybrid vehicles  
[SAW/1335-1]  
21 p0195 A79-12450
- Design and cost study of a nickel-iron oxide battery for electric vehicles. Volume 2: Public report  
[ANL-R-3723-VOL-1]  
21 p0222 A79-14579
- Electric and Hybrid Vehicle Act, Public Law 94-413 demonstration program objective and schedule  
[GPO-98-809]  
22 p0351 A79-18810
- Characterization study of an electric motor-transmission system for electric vehicles  
[HCP/M2835-01]  
22 p0351 A79-18817
- ELECTRIC MOTORS**
- Analysis of a direct coupling d.c. motor and a photovoltaic converter  
21 p0046 A79-12272
- Spatial oscillations of a solid body carrying a low-power flywheel motor --- dual spin spacecraft motion control  
21 p0148 A79-17792
- Characterization study of an electric motor-transmission system for electric vehicles  
[HCP/M2835-01]  
22 p0351 A79-18817
- ELECTRIC NETWORKS**
- Validation of an electric circuit model of a solar house  
22 p0321 A79-31440
- ELECTRIC POTENTIAL**
- Observation of voltage fluctuations in a Superconducting Magnet during MHD power generation  
22 p0235 A79-20531
- Electrical power loss from high-voltage power circuits through plasma leakage  
21 p0169 A79-10113
- The optimum voltage for batteries used in standby lighting systems  
[BLL-BTS-11512]  
22 p0347 A79-18439
- ELECTRIC POWER**
- Power distribution study for a 5-GW space power satellite  
21 p0002 A79-10026
- Solar Power Satellite thermal analysis  
21 p0003 A79-10028
- Construction of a 10GWe solar power satellite  
21 p0003 A79-10029
- Environmental considerations for the microwave beam from a solar power satellite  
21 p0003 A79-10030
- Microwave phased array design considerations for SPS --- Solar Powered Satellites  
21 p0003 A79-10031
- A 5-GWe nuclear satellite power system conceptual design  
21 p0003 A79-10033
- Closed Cycle Gas Turbine power generation opportunities  
21 p0004 A79-10039
- High efficiency thermal energy storage system for utility applications  
21 p0012 A79-10102
- Laboratory evaluation of a composite flywheel energy storage system  
21 p0013 A79-10110
- Molten carbonate fuel cell systems - Status and potential  
21 p0039 A79-11817
- Partial processes and transport parameters in molten carbonate fuel cell operation  
21 p0040 A79-11819
- Thin film high temperature solid electrolyte fuel cells  
21 p0040 A79-11820
- Thermodynamic and kinetic considerations on zinc-halogen batteries  
21 p0040 A79-11822
- Thermal energy storage heat exchanger design  
[ASME PAPER 78-ENAS-30]  
21 p0049 A79-12579
- The wind as a potential energy source in future hydrogen technology  
21 p0059 A79-13661
- Generation of electrical energy from hydrogen and oxygen by means of fuel cells  
21 p0059 A79-13662
- Modelling energy storage systems for electric utility applications Preliminary considerations  
21 p0081 A79-14960
- Perspective on the fusion-fission energy concept  
21 p0095 A79-15913
- Energy conservation by means of recycling  
21 p0112 A79-16735
- Bio-mass energy for rural areas  
21 p0126 A79-17373
- 1MW calorimetric receiver for Solar Thermal Test Facility  
[ASME PAPER 78-WA/SOL-7]  
21 p0163 A79-19839
- Electromagnetic excitation of a moving conducting piston  
22 p0237 A79-20658
- New chemical sources of current --- Russian book  
22 p0237 A79-20679
- Geothermal energy in Imperial County, California Environmental, socio-economic, demographic, and public opinion research conclusions and policy recommendations  
22 p0265 A79-24046
- Risk with energy from conventional and nonconventional sources  
22 p0266 A79-24151
- Energy for Europe from space  
22 p0273 A79-25605
- Evaluation of the effectiveness of electric power systems for transport purposes  
22 p0284 A79-26723
- A proposed thermophotovoltaic solar energy conversion system  
22 p0287 A79-27317
- A Variable Speed Constant Frequency /VSCF/ wind generator for low power applications  
22 p0303 A79-29799
- Program information notice --- technologies relevant to u.s. electric energy systems  
[DOE/ET-0059]  
21 p0207 A79-13517
- Current and projected fuel costs --- electric rate schedules and projected costs of fossil, synthetic, and nuclear fuels  
21 p0218 A79-14532
- USAF terrestrial energy study. Volume 3, part 1: Summary data display  
[AD-A061071]  
22 p0342 A79-17341
- ELECTRIC POWER PLANTS**
- A new power cycle that combines power generation with energy storage  
21 p0004 A79-10040
- Conceptual design and cost estimate 600 MWe coal fired fluidized-bed combined cycle power plant  
21 p0008 A79-10068
- Computer aided optimization of integrated coal gasification combined cycle power plants  
21 p0008 A79-10075
- The LASH /laser-ash/ particulate fragmentation removal concept for coal fired turbine power plants  
21 p0009 A79-10078

## ELECTRIC POWER PLANTS CONTD

## SUBJECT INDEX

Advances in lower cost phosphoric acid fuel cells  
21 p0010 A79-10092

100MWh zinc-chlorine peak-shaving battery plants  
21 p0011 A79-10096

A technical analysis for cogeneration systems with potential applications in twelve California industrial plants --- energy saving heat-electricity utility systems  
21 p0011 A79-10099

Performance of a 10 MW geothermal energy conversion test facility  
21 p0014 A79-10119

Optimum design conditions for a power plant at a vapor dominated geothermal resource, Pacific Gas and Electric's The Geysers Power Plant Unit 16  
21 p0014 A79-10121

Fossil superheating in geothermal steam power plants  
21 p0014 A79-10122

Heat exchanger design for geothermal power plants  
21 p0015 A79-10123

Hydrocarbon working fluid and operating conditions selection for the conventional geothermal binary cycle  
21 p0015 A79-10124

Effect of noncondensable gases on geothermal power generation  
21 p0015 A79-10125

Assessment of the potential of generating power from aqueous saline solutions by means of Osmo-Hydro Power systems  
21 p0016 A79-10133

Economic optimization of the coal-fired MHD Steam Power Plant  
21 p0016 A79-10134

Reducing combustion air temperature variations in magnetohydrodynamic/steam power plants  
21 p0016 A79-10135

Considerations for MHD power generation development  
21 p0016 A79-10136

A proposed 40 MWe MHD pilot plant  
21 p0017 A79-10137

Thermal modeling of coal-fired MHD plant components  
21 p0017 A79-10138

CO2-laser fusion  
21 p0018 A79-10150

Energy conversion in the long run  
21 p0019 A79-10154

Preliminary design of the solar total energy-large scale experiment at Shenandoah, Georgia  
21 p0019 A79-10159

Conceptual design of the Fort Hood Solar Total Energy-Large Scale Experiment  
21 p0019 A79-10160

JPL - Small Power Systems Applications Project --- for solar thermal power plant development and commercialization  
21 p0019 A79-10161

Performance and economic risk evaluation of dispersed solar thermal power systems by Monte Carlo simulation  
21 p0020 A79-10163

Comparative evaluation of distributed-collector solar thermal electric power plants  
21 p0021 A79-10173

Operating experience at the DOE/Sandia midtemperature Solar Systems Test Facility  
21 p0022 A79-10182

A free-piston Stirling engine for small solar power plants  
21 p0024 A79-10205

The Department of Energy's thermionic energy conversion program  
21 p0025 A79-10213

Thermionic power plant design point selection - The economic impact  
21 p0025 A79-10214

A summary of USSR thermionic energy conversion activity  
21 p0026 A79-10216

Electric power from laser fusion - The HYLIPE concept  
21 p0030 A79-10249

Economic methodology for solar power-generating systems  
21 p0030 A79-10251

Scaling up coal liquids  
21 p0031 A79-10475

Second-generation integrated coal gasification/combined-cycle power systems [ASME PAPER 78-GT-14]  
21 p0032 A79-10778

ERDA fuel cell programs  
21 p0039 A79-11814

Analysis of electrolyte shunt currents in fuel cell powerplants  
21 p0039 A79-11816

Perspectives on utility central station photovoltaic applications  
21 p0041 A79-11873

Predicted performance of heliostats for ERDA's 10 MWe power plant  
21 p0044 A79-12045

Solar thermal electric power systems - Manufacturing cost estimation and systems optimization  
21 p0046 A79-12273

Magnetohydrodynamic/steam power plant modeling and control  
21 p0046 A79-12274

U-25B MHD unit for carrying out investigations under the conditions of strong electric and magnetic fields  
21 p0049 A79-12692

Solar power plants in the U.S.A.  
21 p0057 A79-13640

Small solar power plant with a Freon turbine  
21 p0057 A79-13642

Solar One - A 10-megawatt solar thermal central receiver pilot plant project [AIAA PAPER 78-1750]  
21 p0060 A79-13853

Dynamic computer simulation of the DOE 10 MW solar thermal pilot plant [AIAA PAPER 78-1752]  
21 p0060 A79-13854

Alternative central receiver solar power plant using salt as a heat transfer and storage medium [AIAA PAPER 78-1753]  
21 p0060 A79-13855

Advanced processes for generation of electric power - Solvent refining of coal and combined cycle plants  
21 p0064 A79-14110

Energy consumption of environmental controls - Fossil fuel, steam electric generating industry  
21 p0064 A79-14112

Fuel-cell power plants  
21 p0068 A79-14398

Low head power generation with bulb turbines --- hydroelectric installations  
21 p0074 A79-14705

Design study of a thermohydraulic loop for the conversion of geothermal energy /low enthalpy/ into electricity  
21 p0076 A79-14741

The oxidation of sulfur dioxide to sulfate aerosols in the plume of a coal-fired power plant  
21 p0076 A79-14757

Salinity power station at the Swedish west-coast - Possibilities and energy-price for a 200 MW-plant  
21 p0077 A79-14772

Fuel cell on-site integrated energy system parametric analysis of a residential complex  
21 p0081 A79-14947

The impact of a coal fired power plant on ambient sulfur dioxide levels  
21 p0082 A79-15032

On the depletion of ambient ozone by a rural coal-fired power plant near Portage, Wisconsin  
21 p0082 A79-15052

Operation and control of wind-electric systems  
21 p0086 A79-15575

Power from glaciers - The hydropower potential of Greenland's glacial water  
21 p0087 A79-15672

External single pass to superheat receiver --- for central receiver solar power plant [AIAA PAPER 78-1751]  
21 p0089 A79-15849

An introduction to ocean thermal energy conversion /OTEC/ power plants  
21 p0091 A79-15869

A central receiver solar thermal power system  
21 p0091 A79-15872

Geothermal energy from a utility perspective --- Imperial Valley of Southern California  
21 p0091 A79-15880

Large wind turbine generators --- NASA program status and potential costs  
21 p0092 A79-15881

# SUBJECT INDEX

# ELECTRIC POWER PLANTS CONTD

- Utility applications of wind power plants 21 p0092 A79-15882
- A commentary on a methodology for assessment of the environmental impact of the electrical power system within the Connecticut River Basin 21 p0093 A79-15893
- Role and status of dispersed electric utility fuel cell power plants 21 p0093 A79-15894
- Development of central station power plants integrated with coal gasifiers --- utilizing molten-carbonate fuel cells 21 p0093 A79-15895
- Market penetration for OTEC 21 p0094 A79-15903
- Incentives and requirements for gasification based power systems 21 p0094 A79-15904
- Hybrid fossil-geothermal power plants 21 p0096 A79-15920
- Increasing the efficiency of coal-fired steam electric plants with thermionic topping 21 p0096 A79-15921
- Coal-based electricity and air pollution control - A case for solvent refined coal 21 p0096 A79-15922
- Westinghouse fluidized bed coal gasification system - Experience and plans 21 p0096 A79-15924
- A proposed conceptual plan for integration of wind turbine generators with a hydroelectric system 21 p0098 A79-16107
- An overview of the U.S. OTEC development program 21 p0100 A79-16247
- Capital cost system optimization of OTEC power modules 21 p0101 A79-16249
- Advances in ocean engineering aspects of ocean thermal energy conversion 21 p0101 A79-16250
- Power cables to accommodate the motions of an OTEC plant 21 p0101 A79-16251
- Open-cycle magnetohydrodynamic electrical power generation --- Book 21 p0104 A79-16478
- The MHD power plant and its environmental aspects - Introduction 21 p0105 A79-16479
- MHD power plant characteristics 21 p0105 A79-16480
- Layout and design characteristics of MHD power stations 21 p0105 A79-16481
- Technical and economic aspects of open-cycle MHD power plants 21 p0105 A79-16482
- Protection of the biosphere --- MHD power stations pollution reduction 21 p0105 A79-16483
- Steam generator and turbomachines --- MHD power plant design and Soviet operational experience 21 p0106 A79-16489
- Radiatively sustained cesium plasmas for solar electric conversion 21 p0109 A79-16615
- Energy storage for tokamak reactor cycles --- during downtime for periodic plasma quench and reignition 21 p0111 A79-16727
- Solar Thermal Electric Program 21 p0112 A79-16730
- A status report on the Solar Thermal Test Facility 21 p0112 A79-16731
- Non-adaptive optics for solar thermal electric power 21 p0112 A79-16733
- Energy requirements of a limestone FGD system --- Flue Gas Desulfurization 21 p0114 A79-16747
- Advanced emissions control and test facility of the Electric Power Research Institute 21 p0115 A79-17249
- Estimation of collector and electrical energy cost for STEPS in Japan --- Solar Thermal Electric Power System 21 p0118 A79-17288
- Energy storage requirements for autonomous and hybrid solar thermal electric power plants 21 p0120 A79-17315
- Mechanical energy storage system for a 10 KWe solar power pack 21 p0121 A79-17329
- Analysis of thermal storage unit for solar energy 21 p0122 A79-17332
- The feasibility of constructing a photoelectric unit utilizing effluent heat 21 p0125 A79-17358
- An analysis of a cylindrical parabolic focussing collector for distributed collector power system 21 p0134 A79-17442
- Design of solar energy concentrators for power generation in residential and nonresidential areas 21 p0136 A79-17460
- Exploitation of solar energy via modular power plants and multiple utilization of waste heat 21 p0141 A79-17497
- The French CNRS 1 MW solar power plant 21 p0141 A79-17498
- A small solar power plant with a freon turbine 21 p0141 A79-17501
- Development of small solar power plants for rural areas in India 21 p0141 A79-17502
- Power plant systems based on solar energy --- powered by sea water evaporation-produced osmotic pressure head mechanical energy 21 p0142 A79-17508
- A reflector concentrator modified sterling engine unit and an aqua-ammonia absorber gas turbine unit for farm power needs 21 p0142 A79-17509
- Master control and data system for the 5MW Solar Thermal Test Facility 21 p0144 A79-17620
- Gasification Combined Cycle Test Facility at Pekin, Illinois 21 p0145 A79-17632
- MHD power generation 21 p0146 A79-17638
- Emission control for SO<sub>2</sub> - An update [ASME PAPER 78-JPGC-PWR-11] 21 p0150 A79-18097
- Operating experience with three 20 MW prototype flue gas desulfurization processes [ASME PAPER 78-JPGC-PWR-12] 21 p0150 A79-18098
- Tidal power plants - Sites, history and geographical distribution 21 p0150 A79-18102
- Selection of optimum sites for tidal power development in the Bay of Fundy 21 p0152 A79-18110
- The role of tidal power stations in future scenarios for electricity storage in U.K. 21 p0152 A79-18116
- Integrating wave power into the electricity supply system 21 p0152 A79-18117
- Emissions of nitrogen dioxide from a large gas-turbine power station 21 p0152 A79-18344
- The Madaras Rotor Power Plant - An alternate method for extracting large amounts of power from the wind [AIAA PAPER 79-0115] 21 p0157 A79-19541
- National program for the development of commercial MHD [AIAA PAPER 79-0188] 21 p0157 A79-19587
- Floating dry cooling, a competitive alternative to evaporative cooling in a binary cycle geothermal power plant [ASME PAPER 78-WA/ENER-2] 21 p0159 A79-19775
- The Stirling engine, an energy converter for cogeneration applications [ASME PAPER 78-WA/ENER-4] 21 p0159 A79-19777
- Trace element emissions from coal-fired power plants [ASME PAPER 78-WA/FU-9] 21 p0160 A79-19789
- Gas stream composition and temperature determination in a coal-fired MHD simulation facility [ASME PAPER 78-WA/HT-23] 21 p0161 A79-19810
- The use of heat exchangers with THERMOEXCEL's tubing in ocean thermal energy power plants [ASME PAPER 78-WA/HT-65] 21 p0162 A79-19825
- Parametric analysis of power conversion systems for central receiver solar power generation [ASME PAPER 78-WA/SOL-2] 21 p0162 A79-19835
- Tidal power in the Bay of Fundy 22 p0237 A79-20729

## ELECTRIC POWER PLANTS CONTD

## SUBJECT INDEX

- A ceramic heat exchanger for a Brayton cycle solar electric power plant 22 p0239 A79-20822
- Composite material flywheels for energy storage on electricity supply systems 22 p0241 A79-20852
- Analysis and design of a field of heliostats for a solar power plant 22 p0242 A79-21161
- Economic prospects for the application of new electric energy storage devices 22 p0246 A79-21490
- Mining earth's heat - Hot dry rock geothermal energy 22 p0258 A79-23280
- Industrial cogeneration - Problems and promise --- waste heat utilization from electricity production 22 p0265 A79-24047
- The geothermal power station at Ahuachapan, El Salvador 22 p0266 A79-24239
- Soil cooling for geothermal electric power plants in the Western United States - The Raft River experiment 22 p0266 A79-24240
- Storage peak gas-turbine power plant --- compressor for electric energy storage 22 p0268 A79-24507
- Medium-power /100-1000 kWe/ solar power plants using distributed collectors 22 p0269 A79-24622
- Space reflector technology and its system implications [AIAA PAPER 79-0545] 22 p0273 A79-25852
- No ill winds for New Mexico utility --- windpower utilization in municipal electric power system 22 p0286 A79-27208
- Induction-generator/synchronous-condenser system for wind-turbine power 22 p0286 A79-27219
- Technology considerations in the design of a commercial offshore energy conversion /OTEC/ plant 22 p0288 A79-27378
- Performance of a 5 MWT solar steam generator 22 p0288 A79-27399
- Open-cycle MHD development --- for power generation 22 p0289 A79-27659
- Solar thermal electrical power plants for Iran 22 p0295 A79-28352
- Optical analysis of solar facility heliostats 22 p0296 A79-28360
- Optimum power plant capacity of ocean-based ocean thermal energy conversion systems 22 p0297 A79-28922
- Cogeneration in Europe and the combined cycle gas turbine 22 p0297 A79-28988
- Gas turbine operating and maintenance experience in Saudi Arabia 22 p0298 A79-28989
- Thermodynamic basis for combining cycles of heat producing power plants 22 p0298 A79-29297
- Ways of improving steam-gas power plants --- fuel economy 22 p0299 A79-29298
- Wind power and electric utilities - A review of the problems and prospects 22 p0300 A79-29374
- Feasibility of MHD-ac induction electric power plant --- using tokamak reactor exhaust plasma 22 p0303 A79-29794
- Development and application of techniques to evaluate cogeneration impacts --- simultaneous electric energy and process heat production in electric power plants 22 p0303 A79-29795
- Control problems of the magnetohydrodynamic electrical power generation in power station cooperating with electrical power system 22 p0303 A79-29798
- The impact of alternate energy resources on the future supply of electric power [IEEE PAPER P 78 672-8] 22 p0304 A79-29939
- Energy, resources, and policy --- Book 22 p0304 A79-30175
- Conceptual design of a solar powered closed-cycle gas turbine electric power generation system [ASME PAPER 79-GT-43] 22 p0306 A79-30522
- Study of integrated gasification combined cycle plant interaction and control [ASME PAPER 79-GT-60] 22 p0306 A79-30530
- Structural cost optimization of photovoltaic central power station modules and support structure [ASME PAPER 79-SOL-17] 22 p0309 A79-30551
- Benefits of solar/fossil hybrid gas turbine systems [ASME PAPER 79-GT-38] 22 p0309 A79-30554
- Chemical studies of stack fly ash from a coal-fired power plant 22 p0309 A79-30595
- Solar power plants --- thermoelectric conversion in Canada 22 p0318 A79-31416
- A scheme for direct conversion of plasma thermal energy into electrical energy 22 p0324 A79-31765
- Particulate and sulfur dioxide emission control costs for large coal-fired boilers [PB-281271/7] 21 p0178 A79-10594
- Low NOx combustion concepts for advanced power generation systems firing low-Btu gas [PB-282983/6] 21 p0178 A79-10610
- International project catalog of modular integrated utility systems [PB-283477/8] 21 p0190 A79-11544
- Committee on the Challenges of Modern Society Rational use of Energy Pilot Study Modular Integrated Utility Systems Project. Volume 1: Description, activities, and products [PB-283428/1] 21 p0190 A79-11549
- Regional air pollution study: Heat emission inventory [PB-284081/7] 21 p0200 A79-12602
- Technical notes for the conceptual design for an atmospheric fluidized-bed direct combustion power generating plant [HCP/T2583-01/2] 21 p0203 A79-13280
- Solar electric power generation, volume 2. Citations from the NTIS data base [NTIS/PS-78/1108/6] 21 p0212 A79-13557
- Environmental control implications of generating electric power from coal. Appendix A, part 2: Coal preparation and cleaning assessment study appendix [ANL/ECT-3-APP-A-PT-2] 21 p0213 A79-13571
- Assessment of the solid waste impact of the National Energy Plan [BNL-50708] 21 p0213 A79-13572
- An assessment of mercury emissions from fossil fueled power plants [PB-285227/5] 21 p0213 A79-13592
- Lead-acid battery: An evaluation of commercialization strategies [MTR-7593] 21 p0220 A79-14565
- Use of waste heat from thermal electric power plants and nuclear power plants to heat greenhouses [ORNL-TR-4483] 21 p0221 A79-14574
- Combined cycle power generation. Citations from the NTIS data base [NTIS/PS-78/1156/5] 21 p0222 A79-14587
- Combined cycle power generation. Citations from the Engineering Index data base [NTIS/PS-78/1157/3] 21 p0222 A79-14588
- Cooling systems addendum: Capital and total generating cost studies [PB-287306/5] 21 p0231 A79-15431
- Large closed-cycle gas turbine plant [GA-A-14311] 22 p0331 A79-16261
- Local perceptions of energy development: The case of the Kaiparowits Plateau [PB-287314/9] 22 p0335 A79-16380
- Environmental assessment for residual oil utilization [PB-286982/4] 22 p0336 A79-16446
- Description of hydro-electric development and proposal for future development on the Zambezi 22 p0340 A79-17323
- Evaluation of the ECAS open cycle MHD power plant design [NASA-TN-79012] 22 p0341 A79-17335
- Ecological effects of coal-fired steam-electric generating stations 22 p0346 A79-18358
- Austrian 10kWe solar power plant. A project of the Federal Ministry for Science and Research 22 p0349 A79-18460

# SUBJECT INDEX

# ELECTRIFICATION

- Coal and nuclear: A comparison of the cost of generating baseload electricity by region [PB-289585/2] 22 p0355 N79-19469
- Technical support for open-cycle MHD program [ANL-MHD-78-8] 22 p0361 N79-20507
- Measurement and control techniques in geothermal power plants [TREE-1312] 22 p0362 N79-20508
- Environmental impact determination of action to be taken under the Energy Supply and Environmental Coordination Act for powerplants 1, 2, 3, and 4, Portsmouth Generating Station, Portsmouth, Virginia [DOE/EA-0033] 22 p0362 N79-20514
- Air quality impacts using SRC versus conventional coal in power plants [PB-290237/7] 22 p0373 N79-21671
- A biologist's manual for the evaluation of impacts of coal-fired power plants on fish, wildlife and their habitats [PB-291330/9] 22 p0373 N79-21679
- ELECTRIC POWER SUPPLIES**
- Development and evaluation of a 600-kWh lithium-hydrogen peroxide reserve power system 21 p0011 A79-10095
- Recent terrestrial and undersea applications of radioisotope thermoelectric generators /RTGs/ 21 p0027 A79-10226
- Advanced wind furnace systems for residential and agricultural heating and electrical supply applications 21 p0028 A79-10237
- Thyristor controlled rectifier inverting at unity power factor 21 p0033 A79-10898
- Advancements in the design of solar array to battery charge current regulators 21 p0033 A79-10902
- Solar electric power supplies - Design and layout 21 p0057 A79-13639
- The impact of advanced technology on the future electric energy supply problem 21 p0112 A79-16736
- Solar cell modules for terrestrial use 21 p0149 A79-17996
- Electrochemical utilization of metal hydrides 22 p0251 A79-21709
- Determining the reliability of radioisotope thermoelectric generators /RTGs/ designed for terrestrial and undersea applications 22 p0261 A79-23622
- Recent terrestrial and undersea applications of radioisotope thermoelectric generators /RTGs/ 22 p0261 A79-23623
- Air Force applications of lightweight superconducting machinery --- in airborne power sources 22 p0290 A79-27666
- Off-peak electrical backup experience in the Meadowvale Solar Experiment 22 p0318 A79-31421
- OAST space power technology program 21 p0169 N79-10123
- Comprehensive overview of winter energy data bulletins [PB-282787/1] 21 p0177 N79-10565
- Applications of thermal energy storage to process heat and waste heat recovery in the iron and steel industry [NASA-CR-159397] 21 p0183 N79-11473
- Energy programs at The Johns Hopkins University Applied Physics Laboratory [PB-283171/7] 21 p0191 N79-11554
- Energy programs at The Johns Hopkins University Applied Physics Laboratory [PB-283170/9] 21 p0191 N79-11555
- An annotated compilation of the sources of information related to the usage of electricity in non-industrial applications [PB-285260/6] 21 p0212 N79-13552
- The 25 kW power module updated baseline system --- for space transportation system payloads [NASA-TN-78212] 21 p0226 N79-15247
- Comparison of fuel-cell and diesel integrated energy systems and a conventional system for a 500-unit apartment [NASA-TN-79037] 21 p0229 N79-15403
- Power supplies for Arctic radio repeater systems [AD-A061609] 22 p0339 N79-17118
- USAF terrestrial energy study. Volume 3, part 1: Summary data display [AD-A061071] 22 p0342 N79-17341
- The 25 kW power module evolution study. Part 3: Conceptual designs for power module evolution. Volume 2: Program plans [NASA-CR-161146] 22 p0345 N79-17890
- ELECTRIC POWER TRANSMISSION**
- Market penetration for OTEC 21 p0094 A79-15903
- 30-MJ superconducting magnetic energy storage /SMES/ unit for stabilizing an electric transmission system 22 p0237 A79-20555
- Study of heat engine/flywheel: Hybrid propulsion configuration with electrical transmission system. Phase 2: Design definition [ALO-41/2] 21 p0185 N79-11493
- Microwave power transmitting phased array antenna research project [NASA-CR-157843] 21 p0202 N79-13263
- ELECTRIC PULSES**
- Pulse characteristics of sodium sulfur cells for electric vehicle propulsion 21 p0009 A79-10082
- Contribution to the theory of the pulsed mode of operation of the thermionic energy converter. II 22 p0246 A79-21542
- ELECTRICAL ENGINEERING**
- HIT-DOE program to demonstrate an advanced superconducting generator 22 p0236 A79-20549
- ELECTRICAL FAULTS**
- Mathematical model of interelectrode breakdown in MHD generator 21 p0167 A79-20418
- Transient response to three-phase faults on a wind turbine generator 21 p0180 N79-11312
- ELECTRICAL GROUNDING**
- Lightning protection for the vertical axis wind turbine [SAND-77-1241] 21 p0221 N79-14567
- ELECTRICAL MEASUREMENT**
- Improvement of direct-current electrical prospecting methods for the geothermal investigation of the Rhine Graben 21 p0075 A79-14734
- ELECTRICAL PROPERTIES**
- Interface properties and stability of Schottky barriers and MIS solar cells 21 p0123 A79-17342
- Characterization of solar cells for space applications. Volume 4: Electrical characteristics of Spectrolab BSP 200-micron Helios cells as a function of intensity and temperature [NASA-CR-157934] 21 p0195 N79-12543
- Solid Polymer Electrolyte (SPE) fuel cell technology program [NASA-CR-160159] 22 p0371 N79-21622
- ELECTRICAL RESISTANCE**
- A better approach to the evaluation of the series resistance of solar cells 22 p0281 A79-26242
- ELECTRICAL RESISTIVITY**
- Modified silicon-germanium alloys with improved performance --- thermoelectric material 21 p0027 A79-10225
- Series resistance effects in /GaAl/As/GaAs concentrator solar cells 22 p0273 A79-25745
- Velocity, temperature, and electrical conductivity profiles in hydrogen-oxygen MHD duct flows 22 p0279 A79-26184
- ELECTRICITY**
- Laser power conversion system analysis, volume 1 [NASA-CR-159523-VOL-1] 22 p0366 N79-21334
- Laser power conversion system analysis, volume 2 [NASA-CR-159523-VOL-2] 22 p0366 N79-21335
- ELECTRIFICATION**
- Solar electrification and rural electrification - A techno-economic review 21 p0118 A79-17289

## ELECTRO-OPTICS

Optimization of electrical and optical characteristics of silicon photocells used for photothermal concentrated solar radiation converters

21 p0053 A79-13288

## ELECTROCATALYSTS

The anodic oxidation of ethyleneglycol at platinum, gold and Pt/Au-alloys in alkaline solution --- fuel cell electrocatalysis

21 p0037 A79-11795

Electrocatalysis, charge-transfer and the states of H adsorption in the hydrogen evolution reaction

21 p0038 A79-11801

Recent advances in electrocatalysis and their implications for fuel cells

21 p0038 A79-11807

On the mechanism of the electrocatalytic oxygen reduction with particular regard to metal chelates --- in fuel cell electrodes

21 p0038 A79-11808

Fuel cell electrocatalysis - Where have we failed

21 p0039 A79-11810

Materials for fuel cells

[PB-285360/4] 21 p0212 A79-13553

## ELECTROCHEMICAL CELLS

Electrochemical engines for power generation and load-leveling at sites for underground coal conversion

21 p0005 A79-10051

Polycrystalline CdSe-based photo-electrochemical cells

21 p0037 A79-11785

Growth of refractory oxide layers by electrochemical vapor deposition /EVD/ at elevated temperatures --- for fuel cells

21 p0039 A79-11812

Factors affecting the open-circuit voltage and electrode kinetics of some iron/titanium/redox flow cells

21 p0040 A79-11824

Electrochemistry of lithium/metal sulfide and calcium/metal sulfide cells using molten salt electrolytes

21 p0040 A79-11832

Current state-of-the-art of electrochemical batteries from a users point of view

21 p0071 A79-14681

Energy storage by the use of high temperature electrochemical systems

21 p0148 A79-17992

Development of a 1 kW fuel cell aggregate with acid electrolyte

21 p0148 A79-17994

Selection of thermal operating regimes for fuel cell reactor-condenser systems

21 p0165 A79-20342

New chemical sources of current --- Russian book

22 p0237 A79-20679

Performance of molten salt sodium/beta-alumina/SbCl<sub>3</sub> cells

22 p0245 A79-21479

Influence of composition on the activity of tungsten carbide gas diffusion hydrogen electrodes

22 p0245 A79-21482

Influence of the electrolyte content of oxygen carbon gas-diffusion electrodes on their electro-chemical performance in acid solutions

22 p0245 A79-21483

Silver selenate and silver tellurate as positive materials for lithium primary power sources

22 p0245 A79-21484

Metal hydride electrodes for electrochemical energy storage

22 p0249 A79-21695

Electrochemical utilization of metal hydrides

22 p0251 A79-21709

Electrochemical use of Biomass

22 p0254 A79-22273

Low voltage behavior of lithium/metal dichalcogenide topochemical cells

22 p0286 A79-26995

Steady-state composition profiles in mixed molten salt electrochemical devices. II - Molten carbonate fuel cell analogs

22 p0305 A79-30333

Comparison of fuel-cell and diesel integrated energy systems and a conventional system for a 500-unit apartment [NASA-TN-79037]

21 p0229 A79-15403

## ELECTROCHEMICAL CORROSION

Casing materials for sodium/sulfur cells

22 p0245 A79-21481

Mechanism of erosion of metal electrodes of the channel of a MHD generator

22 p0306 A79-30391

## ELECTROCHEMISTRY

Symposium on Electrode Materials and Processes for Energy Conversion and Storage, Philadelphia, Pa., May 9-12, 1977, Proceedings

21 p0036 A79-11776

Electrochemical-ellipsometric studies of oxide films formed on nickel during oxygen evolution

21 p0038 A79-11799

Effects of sintering on porous fuel cell electrodes

21 p0039 A79-11818

Electrochemical determinations of the chemical potential and diffusivity of sodium in Na<sub>2</sub>X/TaS<sub>2</sub> at 300°K

21 p0040 A79-11830

A practical electrochemical transport equation for non-dilute solutions --- for energy storage application

21 p0041 A79-11841

Effect of electrolyte impurity on the electrochemical performance of the lead/tetrafluoroboric acid/lead dioxide cell

22 p0246 A79-21485

On the possibility of using silver salts other than Ag<sub>2</sub>CrO<sub>4</sub> in organic lithium cells

22 p0246 A79-21491

Battery and electrochemical systems program summary, FY 1977

[DOE/ET-0014] 21 p0176 A79-10546

Definition of chemical and electrochemical properties of a fuel cell electrolyte

[AD-A058795] 21 p0206 A79-13503

Novel duplex vapor electrochemical method for silicon solar cells

[NASA-CR-158039] 21 p0218 A79-14537

## ELECTRODE FILM BARRIERS

Highly efficient quantum conversion at chlorophyll a-lecithin mixed monolayer coated electrodes --- for solar energy conversion

22 p0273 A79-25548

## ELECTRODEPOSITION

Spectral selective properties of black chrome and nickel electrodeposited coatings for solar absorber

21 p0127 A79-17383

## ELECTRODES

High performance lithium/iron disulfide cells --- for electric vehicle propulsion

21 p0010 A79-10087

Lithium silicon - Iron sulfide load-leveling and electric vehicle batteries

21 p0010 A79-10088

Advances in the development of lithium-aluminum/metal sulfide cells for electric-vehicle batteries

21 p0010 A79-10089

Bipolar lithium/iron disulfide cells --- for electric vehicle propulsion

21 p0010 A79-10090

Symposium on Electrode Materials and Processes for Energy Conversion and Storage, Philadelphia, Pa., May 9-12, 1977, Proceedings

21 p0036 A79-11776

On the mechanism of the electrocatalytic oxygen reduction with particular regard to metal chelates --- in fuel cell electrodes

21 p0038 A79-11808

Effects of sintering on porous fuel cell electrodes

21 p0039 A79-11818

The zinc electrode in sealed alkaline cells

21 p0040 A79-11823

Factors affecting the open-circuit voltage and electrode kinetics of some iron/titanium/redox flow cells

21 p0040 A79-11824

Electrochemistry of lithium/metal sulfide and calcium/metal sulfide cells using molten salt electrolytes

21 p0040 A79-11832



# SUBJECT INDEX

# ELECTROMAGNETIC ABSORPTION

- The secondary lithium electrode in non-aqueous electrolytes - Some problems, some solutions  
21 p0041 A79-11838
- Hydrogen production by conventional and modified water electrolysis  
21 p0059 A79-13659
- The photogalvanovoltaic cell  
21 p0066 A79-14264
- Coal slag effects in MHD generators  
21 p0080 A79-14934
- Mathematical model of interelectrode breakdown in MHD generator  
21 p0167 A79-20418
- Effect of the properties of the working body on the selection of the temperature of the surface of the electrodes of the channel of an MHD generator  
21 p0167 A79-20419
- Mathematics of coiling in cylindrical electrochemical cells - The theory of a spiral bounded by two circles and its application to the spiral-wound nickel-cadmium cell  
22 p0246 A79-21489
- Metal hydride electrodes for electrochemical energy storage  
22 p0249 A79-21695
- Hydrogen storage electrode systems  
22 p0251 A79-21710
- Photoelectrolysis of water with semiconductors  
22 p0259 A79-23343
- Mechanism of erosion of metal electrodes of the channel of a MHD generator  
22 p0306 A79-30391
- Optimization of PtDoped KOCITE (trade name) electrodes in H3PO4 fuel cells  
[AD-A061242] 22 p0342 A79-17340
- Development of economical improved thick film solar cell contact  
[NASA-CR-158358] 22 p0359 A79-20486
- Development, characterization and evaluation of materials for open cycle MHD  
[PNL-2004-9] 22 p0361 A79-20504
- Critical contributions in MHD power generation  
[FE-2215-11] 22 p0362 A79-20511
- Development, characterization and evaluation of materials for open cycle MHD  
[PNL-2004-8] 22 p0369 A79-21557
- Development, testing and evaluation of MHD materials and component designs --- electrode and insulator systems for MHD generators  
[FE-2248-19] 22 p0369 A79-21558
- ELECTRODYNAMICS**
- Subsonic flow in the channel of an MHD-generator  
21 p0167 A79-20413
- Electromagnetic excitation of a moving conducting piston  
22 p0237 A79-20658
- ELECTROHYDRODYNAMICS**
- Two asymptotic solutions for analyzing the transverse edge effect in induction MHD machines  
22 p0298 A79-29287
- ELECTROLYSIS**
- Hydrogen production from high temperature electrolysis and fusion reactor  
21 p0015 A79-10126
- Role of semiconductor properties in photoelectrolysis  
21 p0037 A79-11780
- Iron oxide semiconductor electrodes in photoassisted electrolysis of water  
21 p0037 A79-11781
- Hydrogen production in a solar-hydrogen economy  
21 p0037 A79-11796
- Advanced electrolysis in alkaline solution --- for hydrogen production  
21 p0037 A79-11798
- Electrochemical-ellipsometric studies of oxide films formed on nickel during oxygen evolution  
21 p0038 A79-11799
- Hydrogen production by conventional and modified water electrolysis  
21 p0059 A79-13659
- On the thermal and thermo-electrolytical generation of hydrogen by solar energy  
21 p0059 A79-13660
- A hybrid thermochemical hydrogen production cycle using solar energy process heat  
[AIAA PAPER 78-1779] 21 p0062 A79-13874
- Charge transfer by surface states in the photoelectrolysis of water using a semiconductor electrode  
22 p0254 A79-22320
- Photoelectrolysis of water with semiconductors  
22 p0259 A79-23343
- Progress in solid polymer electrolyte water electrolysis --- for large-scale hydrogen production  
22 p0289 A79-27653
- Discharge reaction mechanisms in Li/SOCl2 cells  
22 p0305 A79-30331
- Electrolysis of zinc. Statistical model of the process parameters for an industrial cell  
[BLL-RTS-11317] 22 p0345 A79-17984
- ELECTROLYTES**
- The state-of-the-art of hydrogen-air phosphoric acid electrolyte fuel cells  
21 p0039 A79-11815
- Analysis of electrolyte shunt currents in fuel cell powerplants  
21 p0039 A79-11816
- Thin film high temperature solid electrolyte fuel cells  
21 p0040 A79-11820
- A practical electrochemical transport equation for non-dilute solutions --- for energy storage application  
21 p0041 A79-11841
- Development of a 1 kW fuel cell aggregate with acid electrolyte  
21 p0148 A79-17994
- Influence of the electrolyte content of oxygen carbon gas-diffusion electrodes on their electro-chemical performance in acid solutions  
22 p0245 A79-21483
- Effect of electrolyte impurity on the electrochemical performance of the lead/tetrafluoroboric acid/lead dioxide cell  
22 p0246 A79-21485
- Technology status: Fuel cells and electrolysis cells  
21 p0170 A79-10133
- The preparation of some novel electrolytes: Synthesis of partially fluorinated alkane sulfonic acids as potential fuel cell electrolytes  
[AD-A056278] 21 p0184 A79-11483
- Evaluation and optimization of Solid Polymer Electrolyte (SPE) fuel cells  
[AD-A058380] 21 p0206 A79-13505
- Solid Polymer Electrolyte (SPE) fuel cell technology program  
[NASA-CR-160159] 22 p0371 A79-21622
- ELECTROLYTIC CELLS**
- Pulse characteristics of sodium sulfur cells for electric vehicle propulsion  
21 p0009 A79-10082
- The photogalvanovoltaic cell  
21 p0066 A79-14264
- Saur vidyut kosh - The solar cell --- reversible charging electrolytic batteries  
21 p0126 A79-17371
- Discharge reaction mechanisms in Li/SOCl2 cells  
22 p0305 A79-30331
- A lithium/dissolved sulfur battery with an organic electrolyte  
22 p0305 A79-30332
- Technology status: Fuel cells and electrolysis cells  
21 p0170 A79-10133
- Definition of chemical and electrochemical properties of a fuel cell electrolyte  
[AD-A058795] 21 p0206 A79-13503
- Fabrication and testing of silver-hydrogen cells  
[NASA-CR-159431] 22 p0334 A79-16374
- ELECTROMAGNETIC ABSORPTION**
- Selective solar absorbers --- coatings for solar collector applications  
21 p0057 A79-13646
- Study of solid-gas-suspensions used for direct absorption of concentrated solar radiation  
22 p0262 A79-23757
- Wave propagation and absorption near the electron-cyclotron layer in the 'THOR' device --- microwave heating of tokamak plasma  
22 p0271 A79-24867
- Selective absorption of solar energy in ultrafine metal particles - Model calculations  
22 p0273 A79-25746

## ELECTROMAGNETIC COMPATIBILITY

## SUBJECT INDEX

Thermodynamics of the conversion of diluted radiation --- solar energy application  
22 p0310 A79-30910

Electromagnetic radiation energy arrangement --- coatings for solar energy absorption and infrared reflection  
[NASA-CASE-W00-00428-1] 22 p0352 W79-19186

**ELECTROMAGNETIC COMPATIBILITY**  
Initial assessment: Electromagnetic compatibility aspects of proposed SPS Microwave Power Transmission System (MPTS) operations  
[PNL-2482] 21 p0202 W79-13252

**ELECTROMAGNETIC FIELDS**  
Electromagnetic excitation of a moving conducting piston  
22 p0237 A79-20658

Calculation of the external electromagnetic field of closely spaced MHD machines  
22 p0298 A79-29285

**ELECTROMAGNETIC PUMPS**  
Calculation and design of liquid-metal MHD induction machines --- Russian book  
22 p0286 A79-27302

Limit of formation of counterflows in plane linear induction MHD machines  
22 p0298 A79-29288

Equations of a conduction MHD ejector  
22 p0298 A79-29289

**ELECTROMAGNETIC RADIATION**  
Some perspectives on research into the biological response to non-ionizing electromagnetic radiation --- relation to SETI, SPS, and other government projects  
22 p0271 A79-24879

**ELECTROMAGNETIC WAVE TRANSMISSION**  
Wave propagation and absorption near the electron-cyclotron layer in the 'THOR' device --- microwave heating of tokamak plasma  
22 p0271 A79-24867

**ELECTROMECHANICAL DEVICES**  
Dispersed power systems and total energy --- solar energy conversion for combined mechanical/electrical and thermal loads  
[ATAA PAPER 78-1770] 21 p0062 A79-13868

Electromechanical conversion of energy during the deceleration of a piston in a uniform magnetic field  
22 p0309 A79-30599

**ELECTROMOTIVE FORCES**  
Thermal converters with transverse thermoelectromotive forces  
22 p0256 A79-22847

**ELECTRON ATTACHMENT**  
Bituminous coal extraction in terms of electron-donor and -acceptor interactions in the solvent/coal system  
22 p0283 A79-26469

**ELECTRON BEAMS**  
Application of electron beams in space for energy storage and optical beam generation  
21 p0108 A79-16606

Characterization of electron and ion current flow in very large aspect-ratio terawatt diodes employing heated and unheated anodes  
21 p0154 A79-18480

An overview of design space for small fusion targets  
22 p0253 A79-22241

Microstability of a focused ion beam propagating through a z-pinch plasma  
22 p0270 A79-24817

Heat exchanges and columnar growth in electron-beam evaporation of silicon films for solar cell applications  
22 p0272 A79-25084

**ELECTRON DENSITY PROFILES**  
Laser measurements of the radial profiles of the electron temperature and density in the FT-1 tokamak  
22 p0244 A79-21430

**ELECTRON DIFFUSION**  
Diffusion length measurements in Schottky barrier GaAs solar cells  
22 p0281 A79-26243

**ELECTRON DISTRIBUTION**  
Transport phenomena in MHD generators - Effect of boundary layers  
21 p0156 A79-19098

## ELECTRON ENERGY

Laser measurements of the radial profiles of the electron temperature and density in the FT-1 tokamak  
22 p0244 A79-21430

Electron cyclotron heating in high density toroidal plasmas  
22 p0265 A79-24037

**ELECTRON MICROSCOPY**  
The iron-titanium - hydrogen system: A transmission electron microscope /TEM/ study  
22 p0285 A79-26947

**ELECTRON PLASMA**  
Non-thermal emission at the plasma frequency --- spectra obtained on tokamak fusion reactors  
22 p0270 A79-24854

Asymptotic theory of dissipative trapped electron mode overlapping many rational surfaces --- in toroidal plasmas  
22 p0270 A79-24855

Wave propagation and absorption near the electron-cyclotron layer in the 'THOR' device --- microwave heating of tokamak plasma  
22 p0271 A79-24867

Characteristics of electron-cyclotron-resonance-heated tokamak power reactors  
22 p0292 A79-27885

## ELECTRON RECOMBINATION

Effects of minority-carrier storage at the interface states on the fill factor of m.i.s. solar cells  
22 p0313 A79-31347

**ELECTRON RUNAWAY (PLASMA PHYSICS)**  
Electrons of high perpendicular energy in the low-density regime of tokamaks  
22 p0270 A79-24852

Non-thermal emission at the plasma frequency --- spectra obtained on tokamak fusion reactors  
22 p0270 A79-24854

On the motion of runaway electrons in momentum space --- analysis for multi-component plasma in tokamaks  
22 p0291 A79-27880

Interpretation of cyclotron radiation spectra from runaway discharges in TFR  
22 p0313 A79-31185

## ELECTRON STATES

Electronic states of concentrated Pd-B alloys from de Haas-van Alphen measurements  
22 p0248 A79-21686

## ELECTRON TUNNELING

On the role of interface states in MOS solar cells  
21 p0156 A79-19092

Charge transfer by surface states in the photoelectrolysis of water using a semiconductor electrode  
22 p0254 A79-22320

## ELECTRON-ION RECOMBINATION

Recombination-induced neutral-particle flux in tokamaks  
22 p0291 A79-27877

## ELECTRONIC CONTROL

Thyristor controlled rectifier inverting at unity power factor  
21 p0033 A79-10898

The application of hydraulics in the 2,000 kW wind turbine generator  
22 p0288 A79-27400

## ELECTRONIC EQUIPMENT

Electronic components in solar technology  
21 p0056 A79-13629

Recent terrestrial and undersea applications of radioisotope thermoelectric generators /RTGs/  
22 p0261 A79-23623

## ELECTRONIC MODULES

Thermal and other tests of photovoltaic modules performed in natural sunlight  
[NASA-CR-158174] 22 p0354 A79-19460

## ELECTROPLATING

Optimization studies on black chrome electroplating variables for solar selective surfaces  
22 p0317 A79-31407

## ELECTROSTATIC GENERATORS

Direct energy converters - Efficiency and cost estimates for two electrostatic concepts  
21 p0046 A79-12266

# SUBJECT INDEX

# ENERGY ABSORPTION FILMS

## ELECTROSTATIC PRECIPITATORS

- Particulate control for coal-fired industrial boilers 21 p0065 A79-14123
- Modification of electrostatic precipitator performance by use of fly-ash conditioning agents [ASME PAPER 78-WA/APC-3] 21 p0158 A79-19736
- On the dynamics of electrostatically precipitated fly ash [ASME PAPER 78-WA/PU-3] 21 p0160 A79-19787
- Electrostatic precipitation tests with fuel oil ash 22 p0296 A79-28390
- Particulate control mobile test units: Third year's operation [PB-283657/5] 21 p0178 A79-10603
- Evaluation of electrostatic precipitator during SRC combustion tests [PB-285864/5] 21 p0223 A79-14618

## ELECTROSTATIC SHIELDING

- Effect of electrode shielding on beamlet-beamlet interaction in multiaperture sources 21 p0154 A79-18481

## ELECTROSTATIC WAVES

- Stability criteria for current-driven drift wave eigenmodes --- in tokamaks 22 p0269 A79-24813
- Theory of anomalous transport due to electrostatic fluctuations --- low frequency plasma instabilities of drift wave type 22 p0270 A79-24858

## ELLIPSOIDS

- Effect of form errors on the characteristics of ellipsoidal radiant energy concentrators 22 p0296 A79-28667

## EMISSION SPECTRA

- Non-thermal emission at the plasma frequency --- spectra obtained on tokamak fusion reactors 22 p0270 A79-24854
- Evidence for neutral-beam-injected oxygen impurities in 2XIB --- mirror confined plasma 22 p0292 A79-27887

## EMISSIVITY

- The measurement of optical properties of selective surfaces using a solar calorimeter 21 p0041 A79-11874
- Flame emissivities - Alternative fuels 21 p0052 A79-12984

## EMPLOYMENT

- Statement of Doctor Krafft A. Ehrlicke, President, Space Global, La Jolla, California 21 p0224 A79-15108

## EMULSIONS

- The emissions and fuel economy of a Detroit diesel 6-71 engine burning a 10-percent water-in-fuel emulsion [AD-A058550] 21 p0203 A79-13375
- Fundamental combustion studies of emulsified fuels for diesel applications [PB-287386/7] 22 p0330 A79-16138
- Proceedings of symposium on water-in-fuel emulsions in combustion --- marine diesels, boilers, and gas turbine engines [AD-A061503] 22 p0338 A79-17019
- Single-cylinder diesel engine tests with unstabilized water-in-fuel emulsions [AD-A062751] 22 p0366 A79-21406

## ENCAPSULATING

- Integral assembly of photovoltaic arrays using glass 22 p0241 A79-20883
- Encapsulation task of the low-cost silicon solar array project. Investigation of test methods, material properties, and processes for solar cell encapsulants [NASA-CR-157939] 21 p0195 A79-12544
- Feasibility study of solar dome encapsulation of photovoltaic arrays [NASA-CR-158368] 22 p0367 A79-21545

## ENDOTHERMIC REACTIONS

- A new thermochemical process for hydrogen production 22 p0312 A79-31153

## ENERGETIC PARTICLES

- Changes in the terrestrial atmosphere-ionosphere-magnetosphere system due to ion propulsion for solar power satellite placement [NASA-TN-79719] 22 p0345 A79-17897

## ENERGY

- Solar irrigation program [SAND-78-0049] 21 p0210 A79-13537

- Energy and the economy: The economic impact of alternative energy supply-demand assumptions [B-PRINT-95-51] 22 p0333 A79-16352

## ENERGY ABSORPTION

- A theory for wave-power absorption by two independently oscillating bodies 21 p0151 A79-18103
- A theory for wave-power absorption by two independently oscillating bodies 22 p0259 A79-23307

## ENERGY ABSORPTION FILMS

- The measurement of optical properties of selective surfaces using a solar calorimeter 21 p0041 A79-11874
- Effect of surface curvature on measurement of the absorptance properties of solar coatings 21 p0042 A79-11879
- Recent progress in thin film polycrystalline solar cells based on cadmium sulfide 21 p0042 A79-11966
- Photovoltaic effects in II-VI heterojunctions 21 p0042 A79-11967
- Optimization of electrical and optical characteristics of silicon photocells used for photothermal concentrated solar radiation converters 21 p0053 A79-13288
- Cu<sub>2</sub>S-CdS thin-film solar cells 21 p0057 A79-13637
- Selective solar absorbers --- coatings for solar collector applications 21 p0057 A79-13646
- Selective coatings for aluminum and steel solar absorbers 21 p0058 A79-13647
- Solaronyx - Selective coating for solar energy absorbers 21 p0058 A79-13648
- DC reactively sputtered metal carbide and metal silicide selective absorbing surfaces --- for photothermal solar energy conversion 21 p0126 A79-17377
- Studies on the selective absorption surface on stainless steel --- for flat type solar collectors 21 p0127 A79-17378
- New processes for black coatings useful in harnessing solar energy. I - A room temperature black chromium plating bath 21 p0127 A79-17379
- Preparation and properties of pure and tin doped indium oxide selective coatings 21 p0127 A79-17381
- Spectral selective properties of black chrome and nickel electrodeposited coatings for solar absorber 21 p0127 A79-17383
- Materials for low-cost solar cells 22 p0252 A79-22099
- Gold, silver, chromium, and copper cermet selective surfaces for evacuated solar collectors 22 p0256 A79-22855
- Microstructure dependence of the optical properties of solar-absorbing black chrome 22 p0256 A79-22858
- Chemical vapor deposited molybdenum films for use in photothermal conversion 22 p0294 A79-28148
- Chemical vapor deposited amorphous silicon for use in photothermal conversion 22 p0294 A79-28149
- Colored stainless steel - A new type of selective absorber --- for solar thermal conversion 22 p0294 A79-28150
- Microstructural characterization of a black chrome solar selective absorber 22 p0294 A79-28151
- New instrumentation for high temperature and hemispherical measurements of selective surfaces --- for solar energy conversion 22 p0294 A79-28152
- Selective-black absorbers using sputtered cermet films 22 p0327 A79-31969
- Black germanium solar selective absorber surfaces 22 p0327 A79-31970

## ENERGY BANDS

## SUBJECT INDEX

## ENERGY BANDS

Effects of minority-carrier storage at the interface states on the fill factor of n.i.s. solar cells

22 p0313 A79-31347

## ENERGY BUDGETS

Building energy standards and codes

21 p0073 A79-14696

Energy balances as a means for the evaluation of solar energy in developing countries

21 p0118 A79-17290

## ENERGY CONSERVATION

A technical analysis for cogeneration systems with potential applications in twelve California industrial plants --- energy saving heat-electricity utility systems

21 p0011 A79-10099

Army facility energy conservation

21 p0028 A79-10233

Simulation study of the effect of fuel-conservative approaches on ATC procedures and terminal area capacity

[SAE PAPES 780523] 21 p0031 A79-10398

Energy conservation aircraft design and operational procedures

[ONERA, TF NO. 1978-107] 21 p0036 A79-11572

The need for materials recycling

21 p0047 A79-12340

National Conference on Energy Conservation in General Aviation, 1st, Kalamazoo, Mich., October 10, 11, 1977, Proceedings

21 p0047 A79-12376

Turbine engines in light aircraft

21 p0047 A79-12380

Energy conservation in general aviation and operation and maintenance of Avco Lycoming piston engines

21 p0048 A79-12381

Economy in flight operations

21 p0048 A79-12383

Flying angle of attack

21 p0048 A79-12384

Ceramic heat exchanger - Applications and developments

21 p0050 A79-12826

Impact of fuel availability and other cost trends on air carrier operations

21 p0053 A79-13077

Impact of fuel availability and other cost trends on general aviation

21 p0053 A79-13078

Pilot's view of the evolving air transport

21 p0053 A79-13085

Design of a low-energy house in Denmark heated by a combination of solar and wind energy

21 p0058 A79-13652

Technology for aircraft energy efficiency

21 p0066 A79-14136

A methodology for evaluating the effectiveness of energy conservation programs

21 p0072 A79-14684

Residential energy design

21 p0073 A79-14694

Quantification of energy resource consumption

21 p0073 A79-14701

A systems study of our energy problems

21 p0074 A79-14704

Conservation as an energy source

21 p0077 A79-14769

Solar energy for residential housing

21 p0090 A79-15857

Identification of cost effective energy conservation measures

21 p0099 A79-16133

The Power Wheel - Elimination of energy-consuming drive components

21 p0112 A79-16734

Energy conservation by means of recycling

21 p0112 A79-16735

Solar energy and the second law of thermodynamics

21 p0118 A79-17292

Design of a low-energy house in Denmark heated by a combination of solar and wind energy

21 p0138 A79-17471

Optimum insulation with internal and solar heat gains

21 p0140 A79-17490

Enhancement of intrinsic solar heating --- thermal performance of house design option

21 p0140 A79-17494

A low energy scenario for the United States - 1975-2050

21 p0147 A79-17649

Energy storage - Economics and fuel conservation

21 p0153 A79-18464

Rule of fuel management --- for airlines

21 p0155 A79-18521

Fuel conservative aircraft engine technology

21 p0164 A79-20078

Toward a materials-conservation ethic

21 p0167 A79-20438

Energy conservation through sealing technology

22 p0237 A79-20700

Dynamic simulation studies of fuel conservation procedures used in terminal areas

22 p0259 A79-23581

Optimization of a novel hydrostatic drive performance using hybrid computing technique --- for automobile engines

22 p0264 A79-23809

What and where - Solar active systems or energy conservation in buildings

22 p0275 A79-25927

CCMS solar energy pilot study reporting format - The zero energy house in Denmark

22 p0277 A79-25940

The Philips experimental house - A system's performance study --- of solar energy utilization and energy conservation

22 p0277 A79-25941

Energy development --- for future global demand

22 p0282 A79-26402

Cogeneration in Europe and the combined cycle gas turbine

22 p0297 A79-28988

Energy analysis of an aluminum solar collector

22 p0316 A79-31405

Distributed energy storage for solar applications

22 p0317 A79-31410

Off-peak electrical backup experience in the Meadowdale Solar Experiment

22 p0318 A79-31421

Allowable costs for alternative domestic heating systems using utility supplied electricity for backup or charging energy

22 p0319 A79-31428

Energy management through energy conservation in buildings

22 p0320 A79-31431

Solutions to energy conservation in northern climates

22 p0321 A79-31443

Prospects for reducing the fuel consumption of civil aircraft

22 p0325 A79-31911

The NASA Aircraft Energy Efficiency program

22 p0325 A79-31912

Chemical production from waste carbon monoxide:

Its potential for energy conservation

[BNWL-2137] 21 p0170 A79-10179

Energy conservation: Policies, programs and general studies. A bibliography with abstracts

[NTIS/PS-78/0693/8] 21 p0176 A79-10552

Outlook for world oil into the 21st century with emphasis on the period to 1990

[EPRI-BA-745] 21 p0181 A79-11454

Transportation Energy Conservation Data Book, edition 2

[ORNL-5320] 21 p0184 A79-11487

Guide to reducing energy-use budget costs

[HCP/U60505-01] 21 p0184 A79-11489

Integrating technologies to produce energy conservation

[CONF-780109-6] 21 p0189 A79-11541

The Federal Government should establish and meet energy conservation goals

[PB-283066/9] 21 p0190 A79-11546

Fuel cell on-site integrated energy system parametric analysis of a residential complex

[NASA-TN-78996] 21 p0193 A79-11955

Energy efficient engine preliminary design and integration study

[NASA-CR-135396] 21 p0194 A79-12084

US Navy energy plan and program, 1978

[AD-A058054] 21 p0197 A79-12560

## SUBJECT INDEX

## ENERGY CONSUMPTION

- Energy future Northwest: Northwest Energy Policy project  
[PB-284697/0] 21 p0199 N79-12578
- Vehicle Design Evaluation Program (VDEP). A computer program for weight sizing, economic, performance and mission analysis of fuel-conservative aircraft, multibodied aircraft and large cargo aircraft using both JP and alternative fuels  
[NASA-CR-145070] 21 p0200 N79-13026
- Aircraft Engine Future Fuels and Energy Conservation [AGARD-LS-96] 21 p0201 N79-13192
- Future fuels for aviation 21 p0201 N79-13193
- Engine component improvement and performance retention 21 p0202 N79-13198
- Low energy consumption engines 21 p0202 N79-13199
- Energy conservation aircraft design and operational procedures 21 p0202 N79-13200
- Solar assisted heat pump study for heating of military facilities 21 p0206 N79-13506
- Three modes of energy cost analysis: Then-current dollars, base-year dollars, and perpetual-constant dollars  
[ORAU/IEA (H)-78-10] 21 p0209 N79-13531
- Planning program to accelerate energy conservation in municipalities  
[RCP/805017-01/1] 21 p0210 N79-13536
- Solar irrigation program [SAND-78-0049] 21 p0210 N79-13537
- Analysis of federal incentives used to stimulate energy production [PNL-2410] 21 p0210 N79-13539
- Utilization of waste heat in trucks for increased fuel economy  
[NASA-TN-79966] 21 p0215 N79-13937
- Energy conservation and the rural home: Economic considerations for the nation and the individual  
[PB-286222/5] 21 p0230 N79-15425
- Energy education training: Feasibility study  
[PB-285910/6] 21 p0230 N79-15428
- Amended Oregon State energy conservation plan, 1978 Prepared in response to the Energy Policy and Conservation Act of 1975 (PL 94-163), and the Energy Conservation and Production Act of 1976 (PL 94-385)  
[PB-286078/1] 21 p0231 N79-15430
- Environmental conservation concerns in transportation: Energy, noise, and air quality  
[PB-286550/9] 21 p0232 N79-15868
- General aviation energy-conservation research programs 22 p0329 N79-15963
- Phase one/base data for the development of energy performance standards for new buildings: Data analysis  
[PB-286901/4] 22 p0331 N79-16148
- Industrial energy conservation [GPO-24-067] 22 p0333 N79-16353
- The effects of resource impact factors on energy conservation standards for buildings  
[PB-286909/7] 22 p0335 N79-16384
- Phase one/base data for the development of energy performance standards for new buildings. Climatic classification  
[PB-286900/6] 22 p0336 N79-16497
- Energy efficient engine: Propulsion system-aircraft integration evaluation  
[NASA-CR-159488] 22 p0337 N79-16850
- Fuel conservative subsonic transport --- control surfaces activated by computers 22 p0337 N79-16874
- Energy conservation: Policy issues and end-use scenarios of savings potential. Part 1: Summary [LBL-7896] 22 p0341 N79-17329
- Life-cycle costing. A guide for selecting energy conservation projects for public buildings --- computing the cost effectiveness of retrofitting and new buildings  
[PB-287804/9] 22 p0345 N79-17744
- Technology assessment of western energy resource development 22 p0347 N79-18368
- Electric and Hybrid Vehicle Act, Public Law 94-413 demonstration program objective and schedule  
[GPO-98-809] 22 p0351 N79-18810
- Phase one/base data for the development of energy performance standard for new buildings. Task report: Building classification  
[PB-286904/8] 22 p0355 N79-19468
- Evaluation of four energy conservation programs--fiscal year 1977  
[PB-288825/3] 22 p0355 N79-19472
- Measuring energy conservation [DOE/EIA-0103/18] 22 p0362 N79-20509
- Single-cylinder diesel engine tests with unstabilized water-in-fuel emulsions  
[AD-A062751] 22 p0366 N79-21406
- The role of thermal energy storage in industrial energy conservation  
[NASA-TN-79122] 22 p0368 N79-21550
- Transportation energy conservation data book, edition 3  
[ORNL-5493] 22 p0369 N79-21562
- The Brookhaven buildings energy conservation optimization model  
[BNL-50828] 22 p0370 N79-21564
- Energy conservation through source reduction  
[PB-290126/2] 22 p0372 N79-21626
- Conservation where it counts: Energy management systems  
[PB-289837/7] 22 p0372 N79-21628
- ENERGY CONSUMPTION**
- User experience with on-road electric vehicles in the U.S.A. and Canada 21 p0009 A79-10080
- Army facility energy conservation 21 p0028 A79-10233
- Energy consumption of environmental controls - Fossil fuel, steam electric generating industry 21 p0064 A79-14112
- Breakdown of rapid rail energy costs - A study of three systems 21 p0068 A79-14323
- Total energy and labor requirements for an electric commuter railroad 21 p0068 A79-14325
- Building energy standards and codes 21 p0073 A79-14696
- Preliminary results of the new geothermal domestic heating system at Creil 21 p0075 A79-14740
- Net energy analysis and environmental aspects for solar tower central receiver systems. I - Methodology 21 p0097 A79-16101
- Analysis and design of solar buildings using the Cal-ERDA computer programs 21 p0137 A79-17463
- Use of solar energy for industrial process heat 21 p0143 A79-17524
- Dornier/RWE solar house in Essen, FRG 22 p0276 A79-25933
- Energy development --- for future global demand 22 p0282 A79-26402
- Energy policy of the European Economic Community 22 p0282 A79-26403
- Climatic change in connection with energy growth --- resource consumption effects 22 p0284 A79-26623
- Metropolitan work-trip energy consumption patterns 22 p0299 A79-29335
- Uncoupling of economic growth and energy consumption - A new strategy of energy politics or only a new slogan 22 p0310 A79-30997
- Fiat Research Center hybrid vehicle prototype [SAE PAPER 790014] 22 p0313 A79-31351
- End use energy consumption data base: Series 1 tables  
[PB-281817/7] 21 p0177 N79-10560
- Energy analysis [NP-23145] 21 p0187 N79-11513
- Urbanism and energy in developing regions [LBL-7808] 21 p0189 N79-11540
- Army energy plan [AD-A057987] 21 p0197 N79-12562
- Impact of electric passenger automobiles on utility system loads, 1985 - 2000 [EPRI-EA-623] 21 p0203 N79-13281

- An annotated compilation of the sources of information related to the usage of electricity in non-industrial applications  
[PB-285260/6] 21 p0212 N79-13552
- Energy use in Japan and the United States  
[BNL-23101] 21 p0221 N79-14578
- LPG in Missouri  
[PB-286329/8] 21 p0230 N79-15421
- Energy education training: Feasibility study  
[PB-285910/6] 21 p0230 N79-15428
- Energy conservation: Policy issues and end-use scenarios of savings potential. Part 1: Summary  
[LEL-7896] 22 p0341 N79-17329
- The world balance for energy needs in view of year 2000: Development of the problem and areas involved, part 2  
[BLL-RISLEY-TR-3395-(9091.9F)] 22 p0347 N79-18442
- The updated algorithm of the Energy Consumption Program (ECP): A computer model simulating heating and cooling energy loads in buildings  
22 p0351 N79-19059
- Alternative models of energy demand  
22 p0353 N79-19440
- The good news about energy  
22 p0355 N79-19461
- Geographical variation in the heating and cooling requirements of a typical single-family house, and correlation of these requirements to degree days  
[PB-289204/0] 22 p0355 N79-19467
- Measuring energy conservation  
[DOE/EIA-0103/18] 22 p0362 N79-20509
- Energy utilization survey pamphlet for buildings  
[AD-A062930] 22 p0371 N79-21624
- ENERGY CONVERSION**
- Intersociety Energy Conversion Engineering Conference, 13th, San Diego, Calif., August 20-25, 1978, Proceedings. Volumes 1, 2 & 3  
21 p0001 A79-10001
- Underground thermal generation of hydrocarbons from dry, southwestern coals  
21 p0005 A79-10050
- Potential of the Stirling engine for stationary power applications in the 500-2000 HP range  
21 p0025 A79-10211
- Materials problems and opportunities in coal conversion systems  
21 p0034 A79-11146
- Symposium on Electrode Materials and Processes for Energy Conversion and Storage, Philadelphia, Pa., May 9-12, 1977, Proceedings  
21 p0036 A79-11776
- Nitinol thermodynamic state surfaces --- heat engine material  
21 p0045 A79-12264
- U-25B MHD unit for carrying out investigations under the conditions of strong electric and magnetic fields  
21 p0049 A79-12692
- Catalysis in coal conversion --- Book  
21 p0051 A79-12873
- Diminide thermionic energy conversion with lanthanum-hexaboride electrodes  
21 p0053 A79-13098
- Low-cost concept for energy supply from the wind  
21 p0058 A79-13651
- Space power technology - Current status and future development trends --- for powering spacecraft  
[DGLR PAPER 78-167] 21 p0063 A79-14054
- Energy technologies and natural environments - The search for compatibility  
21 p0074 A79-14721
- Geothermal energy from a utility perspective --- Imperial Valley of Southern California  
21 p0091 A79-15880
- Energy conversion at a lunar polar site  
21 p0108 A79-16607
- Status and summary of laser energy conversion --- for space power transmission systems  
21 p0111 A79-16635
- The Netherlands experimental vertical axis wind turbine  
21 p0114 A79-17120
- New chemical sources of current --- Russian book  
22 p0237 A79-20679
- Method of producing a p-type or n-type alloy for direct thermoelectric energy conversion  
22 p0260 A79-23615
- An economic analysis of synthetic fuels production from eastern oil shale via hydrotretort processing  
22 p0264 A79-23780
- A mass and energy balance of a Wellman-Galusha gasifier --- bituminous coal conversion  
22 p0283 A79-26467
- Energy conversion engineering --- Book  
22 p0302 A79-29575
- Electromechanical conversion of energy during the deceleration of a piston in a uniform magnetic field  
22 p0309 A79-30599
- MHD gas turbine energy conversion for mirror fusion reactors  
22 p0313 A79-31192
- Alternative power-generation systems  
21 p0169 N79-10129
- Biomass utilization in Minnesota  
[PB-282531/3] 21 p0171 N79-10241
- An evaluation of wood-waste energy conversion systems  
21 p0174 N79-10528
- Preliminary environmental assessment of energy conversion processes for agricultural and forest product residues, volume 1  
[PB-281189/1] 21 p0178 N79-10574
- Multidisciplinary research related to the atmospheric sciences  
[PB-283076/8] 21 p0179 N79-10679
- Program THER energy production units of average power and using thermal conversion of solar radiation  
[NASA-TN-75369] 21 p0183 N79-11474
- Structural performance of the DOE/Sandia 17 meter vertical axis wind turbine  
[SAND-78-0880C] 21 p0187 N79-11516
- Data acquisition and signal processing for a vertical axis wind energy conversion system  
[SAND-78-1000C] 21 p0187 N79-11517
- Civilian applications of laser fusion  
[UCRL-52349] 21 p0195 N79-12439
- Alternative energy sources for Federal Aviation Administration facilities  
[AD-A058681] 21 p0196 N79-12555
- Applied research on energy storage and conversion for photovoltaic and wind energy systems. Volume 2: Photovoltaic systems with energy storage  
[HCP/T22221-01/2-2] 21 p0207 N79-13510
- Applied research on energy storage and conversion for photovoltaic and wind energy systems. Volume 1: Study summary and concept screening  
[HCP/T22221-01/1-VOL-1] 21 p0207 N79-13511
- Siting handbook for small wind energy conversion systems  
[PNL-2521] 21 p0209 N79-13527
- Photovoltaic program: Program summary  
[DOE/ET-0019/1] 21 p0209 N79-13529
- Summary of atmospheric wind design criteria for wind energy conversion system development  
[NASA-TP-1389] 21 p0223 N79-14678
- Magnetohydrodynamic lightweight channel development  
[AD-A060429] 21 p0230 N79-15414
- Total energy consumption for municipal wastewater treatment  
[PB-286688/7] 21 p0231 N79-15439
- USAF terrestrial energy study. Volume 3, part 1: Summary data display  
[AD-A061071] 22 p0342 N79-17341
- Expert opinion on wind energy conversion systems designed by Hermann Honner  
[BHFT-PB-T-77-35] 22 p0349 N79-18456
- Stochastic analysis of wind characteristics for energy conversion  
22 p0350 N79-18535
- Water-related environmental effects in fuel conversion, volume 1. Summary  
[PB-289313/0] 22 p0351 N79-18834
- Methane utilization from coalbeds for power generation  
[TID-28408] 22 p0352 N79-19171
- Applicability of petroleum refinery control technologies to coal conversion  
[PB-288630/7] 22 p0352 N79-19173
- Evaluation of the use of oxygen as oxidant in fossil fuel fired open cycle MHD-steam energy conversion processes  
22 p0353 N79-19444

# SUBJECT INDEX

# ENERGY CONVERSION EFFICIENCY

V-groove multijunction solar cells 22 p0353 N79-19445

Bioconversion study conducted by JPL [NASA-CR-158228] 22 p0354 N79-19450

Wind characteristics program element [PHL-2545] 22 p0356 N79-19568

An improved solar energy receiver for a stirling engine [NASA-CASE-NPO-14619-1] 22 p0362 N79-20513

Preliminary environmental assessment of biomass conversion to synthetic fuels [PB-289775/9] 22 p0365 N79-21224

**ENERGY CONVERSION EFFICIENCY**

Vertical junction silicon solar cell --- for spacecraft power sources 21 p0001 A79-10013

Status of wraparound contact solar cells and arrays --- for spacecraft electric propulsion 21 p0001 A79-10014

The NTS-2 satellite solar cell experiment 21 p0001 A79-10016

Orbiting Solar Observatory /OSO-8/ solar panel design and in-orbit performance 21 p0001 A79-10017

The design and evaluation of a 5 GW GaAlAs solar power satellite /SPS/ 21 p0002 A79-10024

From sunlight in space to 60 Hz on earth - The losses along the way --- satellite solar power transmission efficiency 21 p0003 A79-10027

Advanced industrial gas turbine cooling and high pressure compressor technology 21 p0004 A79-10041

Electrochemical engines for power generation and load-leveling at sites for underground coal conversion 21 p0005 A79-10051

A review of the PFBC combined cycle and its influence on gas turbine design parameters --- Pressurized Fluidized Bed Combustion 21 p0007 A79-10067

Rapid, efficient charging of lead-acid and nickel-zinc traction cells --- for electric vehicles 21 p0009 A79-10084

Response of lead-acid batteries to chopper-controlled discharge --- for electric vehicles 21 p0011 A79-10097

Performance of a Stirling engine powered heat activated heat pump --- gas heating-cooling system 21 p0011 A79-10098

The external combustion steam injected gas turbine for cogeneration 21 p0012 A79-10100

Considerations for MHD power generation development 21 p0016 A79-10136

The fast power cycle for fusion reactors 21 p0018 A79-10152

Energy conversion in the long run 21 p0019 A79-10154

Analysis and design of an 18-ton solar-powered heating and cooling system 21 p0019 A79-10156

Combined cycle gas turbine for an automobile application 21 p0019 A79-10157

Thermal performance trade-offs for point focusing solar collectors 21 p0020 A79-10165

The application of photovoltaic roof shingles to residential and commercial buildings 21 p0020 A79-10170

Comparative evaluation of distributed-collector solar thermal electric power plants 21 p0021 A79-10173

Hybrid air to water solar collector design 21 p0021 A79-10174

Thermosyphon solar water heating system under Brazilian conditions 21 p0021 A79-10177

Heat pipe central solar receiver gas turbine plant 21 p0022 A79-10178

Simulation of solar powered Rankine cycle systems 21 p0022 A79-10179

Compartmental model for agricultural conversion of solar energy into fixed biomass 21 p0022 A79-10181

Operating experience at the DOE/Sandia midtemperature Solar Systems Test Facility 21 p0022 A79-10182

Status of free-piston Stirling engine/linear alternator power conversion system development 21 p0025 A79-10212

Prospects of thermionic power systems 21 p0026 A79-10220

Selenide thermoelectric converter technology 21 p0026 A79-10221

Selenide technology evaluation program at JPL 21 p0026 A79-10222

Analytical predictions of selenide RTG power degradation 21 p0026 A79-10223

Militarized thermoelectric power sources 21 p0027 A79-10227

Solar furnace type high power density thermoelectric generator 21 p0027 A79-10229

Nitinol heat engines for economical conversion of low grade thermal density 21 p0027 A79-10230

Research on the sodium heat engine 21 p0028 A79-10231

DOE/NASA Mod-0A wind turbine performance 21 p0028 A79-10235

Experimental demonstration of the Diffuser Augmented Wind Turbine concept 21 p0029 A79-10238

Torque ripple in a vertical axis wind turbine 21 p0029 A79-10239

Toroidal Accelerator Rotor Platforms for wind energy conversion 21 p0029 A79-10240

Ultra-thin silicon solar cells for high performance panel applications 21 p0029 A79-10243

LAG-Process, some results of utilization in transport and mechanical engineering 21 p0030 A79-10248

Making turbofan engines more energy efficient [ASME PAPER 78-GT-198] 21 p0033 A79-10818

Role of semiconductor properties in photoelectrolysis 21 p0037 A79-11780

Semiconductor liquid junction solar cells - Efficiency, electrochemical stability, and surface preparation 21 p0037 A79-11783

Migrational polarization in high-current density molten salt electrochemical devices 21 p0039 A79-11811

Electrochemical characteristics of ZrO2-Y2O3 solid electrolytes for fuel cells 21 p0039 A79-11813

Perspectives on utility central station photovoltaic applications 21 p0041 A79-11873

Theoretical upper limit to the conversion efficiency of solar energy 21 p0042 A79-11876

Optimum antireflection coating for Antireflection-coated Metal-Oxide-Semiconductor /AMOS/ solar cells 21 p0042 A79-11955

Recent progress in thin film polycrystalline solar cells based on cadmium sulfide 21 p0042 A79-11966

High efficiency solar cells based on indium phosphide 21 p0042 A79-11968

A problem of optimizing the setting angle of sun-battery panels of concave shape --- onboard satellite 21 p0045 A79-12186

Calculation of wake effects in wind turbine parks 21 p0045 A79-12241

Direct energy converters - Efficiency and cost estimates for two electrostatic concepts 21 p0046 A79-12266

Aeroelastic wind energy converter 21 p0047 A79-12275

High efficiency low cost solar cell power 21 p0048 A79-12471

Low-grade thermal energy-conversion Joule effect heat engines [ASME PAPER 78-ENAS-7] 21 p0048 A79-12556

- Channel No. 1 of the MHD generator of a n-25B unit for carrying out investigations in strong electric and magnetic fields 21 p0049 A79-12693
- Energy efficiency in the transport sector 21 p0054 A79-13574
- The efficiencies of thermochemical energy transfer 21 p0054 A79-13575
- Performance of a honeycomb type flat plate collector with serpentine tube 21 p0054 A79-13579
- Return flow solar air-heater 21 p0055 A79-13609
- Testing the efficiency of solar collectors 21 p0056 A79-13627
- Dynamic behaviour of light-weight solar collectors 21 p0056 A79-13628
- Experimental results and concepts of different solar concentrators 21 p0057 A79-13643
- Reduction of the heat loss flux of collectors by infrared reflecting coatings on cover plates 21 p0058 A79-13649
- Generation of electrical energy from hydrogen and oxygen by means of fuel cells 21 p0059 A79-13662
- Dispersed power systems and total energy --- solar energy conversion for combined mechanical/electrical and thermal loads [AIAA PAPER 78-1770] 21 p0062 A79-13868
- Design of a second generation concentrating tracking solar collector [AIAA PAPER 78-1775] 21 p0062 A79-13872
- A hybrid thermochemical hydrogen production cycle using solar energy process heat [AIAA PAPER 78-1779] 21 p0062 A79-13874
- Performance of a tilted solar cell under various atmospheric conditions 21 p0066 A79-14261
- Optimal sizing of solar collectors by the method of relative areas 21 p0066 A79-14263
- Solar water pumping 21 p0066 A79-14266
- Output power variations with solar power satellites 21 p0067 A79-14267
- Progress in laser-fusion research 21 p0070 A79-14464
- Residential energy design 21 p0073 A79-14694
- Determining optimal angles of nonconvex solar battery panel mounting 21 p0080 A79-14837
- A challenging role for the assurance sciences --- in energy conversion technology 21 p0086 A79-15396
- Operation and control of wind-electric systems 21 p0086 A79-15575
- Technique and instrumentation for measuring the performance of integrated solar heating/cooling systems 21 p0087 A79-15830
- Boosting the performance of solar HVAC systems by improving component interactions --- Heating, Ventilating and Air Conditioning 21 p0089 A79-15851
- Solar absorption cooling 21 p0090 A79-15861
- Theory of solar assisted heat pumps 21 p0090 A79-15864
- Incentives and requirements for gasification based power systems 21 p0094 A79-15904
- Hybrid fossil-geothermal power plants 21 p0096 A79-15920
- Increasing the efficiency of coal-fired steam electric plants with thermionic topping 21 p0096 A79-15921
- American Society of Heating, Refrigerating and Air-Conditioning Engineers, Annual Meeting, Albuquerque, N. Mex., June 25-29, 1978, Technical and Symposium Papers 21 p0101 A79-16415
- Testing of solar collectors according to ASHRAE Standard 93-77 21 p0101 A79-16417
- A graphical approach to the efficiency of flat-plate collectors 21 p0102 A79-16422
- The application of ASHRAE Standard 93-77 to the thermal performance testing of air solar collectors 21 p0102 A79-16423
- Performance of vacuum tube solar collector systems 21 p0102 A79-16424
- Solar electricity production 21 p0104 A79-16467
- The MHD power plant and its environmental aspects - Introduction 21 p0105 A79-16479
- MHD generators --- Faraday, Hall and diagonal generator designs 21 p0105 A79-16484
- A search for space energy alternatives 21 p0108 A79-16608
- Overview of novel photovoltaic conversion techniques at high intensity levels 21 p0108 A79-16610
- Multicolor solar cell power system for space 21 p0108 A79-16611
- Absorption of solar radiation by alkali vapors --- for efficient high temperature energy converters 21 p0108 A79-16612
- MHD conversion of solar energy --- space electric power system 21 p0109 A79-16614
- Thermionics and its application to the SPS --- solar power satellite for energy conversion 21 p0109 A79-16616
- The use of lasers for the transmission of power 21 p0109 A79-16621
- Systems efficiency and specific mass estimates for direct and indirect solar-pumped closed-cycle high-energy lasers in space 21 p0110 A79-16623
- The TELEC - A plasma type of direct energy converter --- Thermo-Electronic Laser Energy Converter for electric power generation 21 p0110 A79-16629
- Quasi-isentropic laser engines 21 p0111 A79-16632
- Generation of the new coherent radiation by harmonic conversion and nonlinear mixing for certain applications --- optical interactions 21 p0111 A79-16639
- Methods for the photochemical utilization of solar energy 21 p0111 A79-16641
- Factors affecting market initiation of solar total energy 21 p0112 A79-16732
- The Power Wheel - Elimination of energy-consuming drive components 21 p0112 A79-16734
- On the use of eddy-current couplings in wind-driven synchronous machines 21 p0113 A79-16742
- Controlling a wind generator for increased efficiency 21 p0113 A79-16743
- Efficient use of wind energy by using static slip recovery systems - A simulator study 21 p0113 A79-16744
- A comparison between sun and wind as energy sources in irrigation plants 21 p0118 A79-17295
- Theoretical and experimental analysis of a latent heat storage system --- solar energy absorbers 21 p0121 A79-17323
- Role of high performance solar cells in practical photovoltaic systems 21 p0122 A79-17336
- Improvement of efficiency and stability by copper-treatment and front contacting of Cu/x/S-CdS solar cells 21 p0123 A79-17345
- Design and fabrication of silicon solar cells for concentrated light 21 p0124 A79-17352
- Response of a solar cell to intense and nonuniform illumination when used with solar concentrators 21 p0125 A79-17357
- Sensitivity calculations for the design of solar cells. I - Schottky barrier devices 21 p0125 A79-17360



# SUBJECT INDEX

# ENERGY CONVERSION EFFICIENCY CONTD

- A diagnostic study on the polycrystalline nature and its relationship with the yield of CdS solar cell 21 p0125 A79-17361
- Efficiency of conventional silicon solar cells 21 p0125 A79-17362
- Efficiency of sugar cane and cowpea as solar energy converters 21 p0125 A79-17368
- Investigation and perspectives on iron oxide, zinc conversion coating, zinc oxide, cobalt oxide and tungsten oxide as spectral selective solar absorber surfaces 21 p0126 A79-17375
- Cheap packed bed absorbers for solar air heaters 21 p0128 A79-17388
- Flat plate collector dynamic evaluation 21 p0128 A79-17390
- A parametric investigation on flat-plate solar collectors 21 p0128 A79-17391
- A comparison among various flat plate collectors with honeycomb structures 21 p0128 A79-17392
- Performance of flat plate solar collector with fluid undergoing phase change 21 p0129 A79-17397
- An interferometric investigation heat transfer in honeycomb solar collector cells 21 p0129 A79-17398
- Effect of dust on flat plate collectors 21 p0129 A79-17399
- Thermal performance of solar collectors used in the national solar heating and cooling demonstration program 21 p0130 A79-17403
- Comparative performance testing of flat-plate solar water heaters 21 p0130 A79-17405
- Proposal for efficient appreciation of solar thermal absorptive materials by high irradiance solar simulator 21 p0130 A79-17406
- Thermal performance testing of flat-plate solar collectors 21 p0130 A79-17407
- The testing procedures of thermal performance of solar collector at Solar Research Lab., G.I.R.I. 21 p0130 A79-17409
- Testing of water-heating collectors according to ASHRAE Standard 93-77 21 p0130 A79-17410
- Double-exposure collector system for solar heating applications 21 p0131 A79-17411
- Field performance of certain selective and neutral surfaces in solar collectors 21 p0131 A79-17417
- Solar collector optimization 21 p0132 A79-17418
- Design and optimization of a flat plate collector for cooling application 21 p0132 A79-17419
- Optimising the pitching of tubes in a flat solar collector for increasing the efficiency for use in vapour absorption refrigeration 21 p0132 A79-17422
- A contribution to evaluation of flat-plate solar collectors performance 21 p0133 A79-17427
- Computer simulation of the performance of a solar pond in the southern part of Iran 21 p0133 A79-17432
- Evacuated solar flat-plate collectors for economic applications 21 p0133 A79-17435
- Construction and test of a test apparatus for determining the efficiency of solar collectors with the ASE-test method 21 p0134 A79-17436
- Theoretical and experimental yields of a solar heater with flat plate collectors 21 p0134 A79-17437
- Performance of optimal geometry three step compound wedge stationary concentrator --- solar collector using flat side mirrors 21 p0134 A79-17438
- A compound parabolic concentrator for a high temperature solar collector requiring only twelve tilt adjustments per year 21 p0134 A79-17439
- Optimum design parameters of horizontal coaxial cylinders for a solar energy collector 21 p0134 A79-17444
- High temperature solar collector of optimal concentration - Non-focusing lens with secondary concentrator 21 p0135 A79-17448
- Performance predictions of a LiBr absorption air conditioner utilizing solar energy 21 p0139 A79-17482
- The attainable efficiency of the solar thermoelectric generators 21 p0140 A79-17496
- Design and performance of 1/4 H.P. solar power unit 21 p0141 A79-17503
- Heat exchangers for Ocean Thermal Energy Conversion plants 21 p0142 A79-17506
- Solar cell modules for terrestrial use 21 p0149 A79-17996
- Solar fuels --- photochemical reaction kinetics and energy storage 21 p0149 A79-18009
- A theory for wave-power absorption by two independently oscillating bodies 21 p0151 A79-18103
- A wave power machine using free floating vertical plates 21 p0151 A79-18104
- Modeling energy and power requirements of electric vehicles 21 p0153 A79-18465
- Some aspects of the transient response of a flat-plate solar energy collector 21 p0153 A79-18466
- The design and testing of a vertical-axis wind turbine using sails 21 p0153 A79-18467
- Gas-cycle solar refrigeration system performance 21 p0153 A79-18471
- A high-efficiency GaAlAs double-heterostructure photovoltaic detector --- with antireflection coating 21 p0154 A79-18489
- Photoacoustic determination of photovoltaic energy conversion efficiency 21 p0154 A79-18503
- Performance testing of solar collectors 21 p0155 A79-18875
- Energy effectiveness of arbitrary arrays of wind turbines [AIAA PAPER 79-0114] 21 p0156 A79-19540
- Floating dry cooling, a competitive alternative to evaporative cooling in a binary cycle geothermal power plant [ASME PAPER 78-WA/ENER-2] 21 p0159 A79-19775
- The Stirling engine, an energy converter for cogeneration applications [ASME PAPER 78-WA/ENER-4] 21 p0159 A79-19777
- The role of interfacial heat and mechanical energy transfers in a liquid-metal MHD generator [ASME PAPER 78-WA/HT-33] 21 p0161 A79-19814
- Limitations of solar assisted heat pump systems [ASME PAPER 78-WA/SOL-1] 21 p0162 A79-19834
- Parametric analysis of power conversion systems for central receiver solar power generation [ASME PAPER 78-WA/SOL-2] 21 p0162 A79-19835
- Efficiency degradation due to tracking errors for point focusing solar collectors [ASME PAPER 78-WA/SOL-4] 21 p0162 A79-19837
- Solar receiver performance of point focusing collector system [ASME PAPER 78-WA/SOL-5] 21 p0163 A79-19838
- Solar collector storage panel [ASME PAPER 78-WA/SOL-12] 21 p0163 A79-19844
- Efficiency improvement by means of multicomponent processes - Improvement of the efficiency of heat-power transformation by means of an employment of Clausius-Rankine sorption processes 21 p0164 A79-19975
- Experimental investigation of the joint operation of wind and solar plants 21 p0167 A79-20358

- Gas turbine with waste heat utilization - Low investment costs and high fuel use efficiency 21 p0168 A79-20448
- Superconducting energy storage magnets 22 p0236 A79-20537
- Optimization of a Knudsen Cs-Ba thermionic converter 22 p0241 A79-20940
- Optimization of an ideal thermionic converter 22 p0241 A79-20941
- Augmented solar energy collection using different types of planar reflective surfaces - Theoretical calculations and experimental results 22 p0242 A79-21166
- The application of thermography to large arrays of solar energy collectors 22 p0242 A79-21171
- Recent advances in Na/S cell development - A review 22 p0246 A79-21488
- Electrochemical utilization of metal hydrides 22 p0251 A79-21709
- Effect of grain boundaries in silicon on minority-carrier diffusion length and solar-cell efficiency 22 p0252 A79-21807
- The oscillating water column wave-energy device 22 p0252 A79-22223
- The synergetics of the catalytic D-D-fusion-fission breeder 22 p0252 A79-22236
- Storage efficiency in a solar plant 22 p0254 A79-22270
- Storage tank efficiency as simulated in a Markovian model of meteorology 22 p0254 A79-22272
- Temperature dependence of photovoltaic solar energy conversion for GaAs homojunction solar cell 22 p0256 A79-22768
- Explanation for low-efficiency Cu<sub>2</sub>O Schottky-barrier solar cells 22 p0256 A79-22859
- Performance of a new high-intensity silicon solar cell 22 p0257 A79-22862
- Optimizing the conversion mode for solar energy 22 p0258 A79-23125
- Wave-tank experiments on an immersed parallel-plate duct --- for testing performance of sub-sea wave energy converter 22 p0258 A79-23306
- A theory for wave-power absorption by two independently oscillating bodies 22 p0259 A79-23307
- Design concepts of solar thermoelectric generators in space applications 22 p0260 A79-23612
- Optimization method of isotopic thermoelectric microgenerator geometry 22 p0260 A79-23613
- Estimating heat loads on multistage thermoelectric heat pumps 22 p0260 A79-23614
- Some effects of leg surface heat losses on the performance of a p-n type thermoelectric generator 22 p0260 A79-23616
- Efficiency of a series of thermoelectric generators in a solar wedge concentrator 22 p0260 A79-23618
- Reversible thermoelectric power conversion of energy fluctuations 22 p0261 A79-23619
- Regenerative burner system for thermoelectric power sources 22 p0261 A79-23621
- High-efficiency AlGaAs/GaAs concentrator solar cells 22 p0261 A79-23710
- On the dynamics of wave-power devices 22 p0269 A79-24539
- Angle-of-incidence effects in electron-beam-deposited SnO<sub>2</sub>/Si solar cells 22 p0272 A79-25069
- An analytical expression for the specific output of wind turbine generators 22 p0273 A79-25720
- Passive solar house in Vetlanda - Interim report 22 p0277 A79-25943
- Fluids engineering in advanced energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978 22 p0278 A79-26176
- Vortex sheet analysis of the Giromill --- vertical axis wind turbine with straight blades 22 p0278 A79-26179
- Wind power distribution, control, and conversion in vortex augmentors --- influence on turbomachinery design and development 22 p0278 A79-26180
- Diffuser designs for improved wind energy conversion 22 p0279 A79-26182
- Two-dimensional MHD channel design --- for energy performance improvement at lower wall temperature 22 p0279 A79-26183
- Subsonic diffusers for MHD generators 22 p0279 A79-26185
- High efficiency wave engine --- featuring rotor blade exit nozzle design for high efficiency 22 p0279 A79-26187
- Modeling two-phase flow in a swirl combustor 22 p0280 A79-26189
- Working fluids and turbines for OTEC power systems 22 p0280 A79-26192
- A better approach to the evaluation of the series resistance of solar cells 22 p0281 A79-26242
- Cavity-type surfaces for solar collectors 22 p0283 A79-26497
- Three-dimensional effects of electrode configuration on diagonal MHD generator performance 22 p0283 A79-26523
- Performance of a closed-cycle MHD generator with molecular impurities 22 p0283 A79-26524
- Performance of combined solar-heat pump systems 22 p0285 A79-26817
- Discharge characteristics of a soluble iron-titanium battery system 22 p0286 A79-26996
- Induction-generator/synchronous-condenser system for wind-turbine power 22 p0286 A79-27219
- Energy from sea waves - System optimization by diffraction theory 22 p0288 A79-27390
- First-order design variables for concentrating solar collectors 22 p0293 A79-28141
- Thermal analysis of black liquid cylindrical parabolic collector 22 p0295 A79-28354
- Results and analysis of a round robin test program for liquid-heating flat-plate solar collectors 22 p0295 A79-28356
- Solar absorption cooling feasibility 22 p0295 A79-28358
- Optimum power plant capacity of ocean-based ocean thermal energy conversion systems 22 p0297 A79-28922
- Operational characteristics of MHD turbine with air-core superconducting rotor 22 p0297 A79-28924
- Cogeneration in Europe and the combined cycle gas turbine 22 p0297 A79-28988
- The design and fabrication of CdS/Cu<sub>2</sub>S cells of 8.5-percent conversion efficiency 22 p0300 A79-29428
- Recent developments in power sources with special emphasis on alkaline batteries --- for electric vehicles 22 p0301 A79-29490
- The role of the battery electric vehicle 22 p0301 A79-29491
- Developing electric vehicles 22 p0302 A79-29496
- Electric car project of the Eindhoven University of Technology 22 p0302 A79-29498
- The limiting efficiency of an edge-illuminated multigap solar cell 22 p0305 A79-30259
- Review of liquid piston pumps and their operation with solar energy [ASME PAPER 79-SOL-4] 22 p0308 A79-30542
- Do photovoltaics have a future [ASME PAPER 79-SOL-7] 22 p0308 A79-30543
- Photovoltaic concentrator system technology and applications experiments [ASME PAPER 79-SOL-9] 22 p0308 A79-30544

# SUBJECT INDEX

# ENERGY POLICY

Unique aspects of terrestrial photovoltaic system design  
[ASME PAPER 79-SOL-14] 22 p0308 A79-30508  
Low cost thin-film CdS-based solar cells progress and promise  
[ASME PAPER 79-SOL-15] 22 p0309 A79-30509  
Superconductivity in antenna engineering 22 p0311 A79-31008  
Superconducting magnets - Present status and problems 22 p0311 A79-31009  
Ranking and evaluation of flat-plate collectors - Two new approaches --- for seasonal storage solar-heating systems 22 p0316 A79-31402  
Optimization of the flow passage geometry for air heating solar collectors 22 p0316 A79-31403  
Performance analysis of a flat-plate solar collector using 'forge-fin' tubes 22 p0316 A79-31404  
A solar collector thermal performance test for developmental programs 22 p0317 A79-31413  
The Saskatchewan Conservation House - Some preliminary performance results 22 p0318 A79-31417  
Performance of the Meadowvale solar home 22 p0318 A79-31420  
Measured and predicted performance of solar domestic water heaters 22 p0319 A79-31422  
The performance of a site built, air heating, vertical collector with snow reflector in Quebec 22 p0319 A79-31423  
A cost effective vertical air/water solar heating collector 22 p0320 A79-31430  
Collector and storage efficiencies in solar heating systems 22 p0320 A79-31432  
The honeycomb heat trap - Its application in flat plate solar collectors 22 p0322 A79-31447  
Cylindrical parabolic collector optimization for interfacing with steam turbine generators 22 p0322 A79-31448  
A hybrid wind turbine suitable for developing regions 22 p0323 A79-31455  
A scheme for direct conversion of plasma thermal energy into electrical energy 22 p0324 A79-31765  
Improved Conversion Efficiency Workshop. Volume 2: Summary  
[CONF-771003-P2-VOL-2] 21 p0176 A79-10551  
Economics of fuel gas from coal: An update including the British Gas Corporation's slagging gasifier  
[EPRI-AP-782] 21 p0180 A79-11238  
Catalytic conversion of coal energy to hydrogen  
[FE-2206-14] 21 p0180 A79-11239  
MSFC hot air collectors  
[NASA-TM-78206] 21 p0196 A79-12556  
The definition of a national program in energy-efficient pump utilization, volume 1  
[HCP/W1260-01/1] 21 p0207 A79-13514  
The definition of a national program in energy-efficient pump utilization. Volume 2: Appendices  
[HCP/W1260-01/2] 21 p0207 A79-13515  
Harnessing tidal energy  
[PB-286671/3] 21 p0222 A79-14581  
Phase one/base data for the development of energy performance standards for new buildings: Data analysis  
[PB-286901/4] 22 p0331 A79-16148  
Silicon web process development  
[NASA-CR-158376] 22 p0357 A79-20282  
Large area silicon sheet by EPG  
[NASA-CR-158379] 22 p0359 A79-20483  
A study of the effective resistance of the diffused layer and its effect on solar cell performance 22 p0367 A79-21541

## ENERGY DISSIPATION

Measurement of heat loss from a heat receiver assembly of a Fixed Mirror Solar Concentrator 21 p0020 A79-10166

Review of tokamak theory results 21 p0069 A79-14454  
Fuel technology and the environment --- nuclear reactor caused radiation effects and transmutation 21 p0079 A79-14787  
The testing procedures of thermal performance of solar collector at Solar Research Lab., G.I.R.I. 21 p0130 A79-17409  
Numerical computation of the loss coefficients for evacuated cylindrical collector receiver tubes  
[ASME PAPER 78-WA/SOL-3] 21 p0162 A79-19836  
Electric power losses of current input into superconducting devices cooled by supercritical helium 22 p0235 A79-20530  
Integral invariants and quasi-NHD nonlinear dissipation --- in magnetized toroidal plasmas 22 p0270 A79-24862  
Heat loss characteristics of an evacuated plate-in-tube collector 22 p0285 A79-26818  
The effect of the dispersion of the characteristics of solar cells in large systems 22 p0285 A79-26822  
Dimensional relations for free convective heat transfer in flat-plate collectors --- solar collector heat loss 22 p0316 A79-31406  
**ENERGY DISTRIBUTION**  
Energy distribution and storage alternates with a centralized heat source 21 p0013 A79-10112  
Use of satellites in solar applications --- for insolation mapping and space power stations 21 p0104 A79-16468  
**ENERGY GAPS (SOLID STATE)**  
The limiting efficiency of an edge-illuminated multigap solar cell 22 p0305 A79-30259  
**ENERGY POLICY**  
Alternatives for coal based power generation - An international overview 21 p0008 A79-10074  
The Department of Energy's thermionic energy conversion program 21 p0025 A79-10213  
Options for solar thermal conversion 21 p0043 A79-11969  
Impact of fuel availability and other cost trends on general aviation 21 p0053 A79-13078  
Hydropower from a national point of view --- projects for future energy production 21 p0059 A79-13656  
Photovoltaic overview  
[AIAA PAPER 78-1763] 21 p0061 A79-13864  
Venture analysis of a proposed federal photovoltaic eight-year procurement plan  
[AIAA PAPER 78-1766] 21 p0061 A79-13865  
Annual Conference on Energy, 4th, University of Missouri-Rolla, Rolla, Mo., October 11-13, 1977, Proceedings. Volume 4 21 p0071 A79-14676  
Coal gasification and its alternatives 21 p0071 A79-14679  
Assessing environmental costs of energy procurement 21 p0071 A79-14682  
Life cycle costing of energy systems 21 p0072 A79-14683  
A methodology for evaluating the effectiveness of energy conservation programs 21 p0072 A79-14684  
A survey of energy information systems and its implications for industrial energy management 21 p0072 A79-14685  
Barriers and incentives to the commercialization of solar heating and cooling of buildings 21 p0072 A79-14687  
The National Program for Solar Energy 21 p0072 A79-14688  
Forest residues as an alternate energy source 21 p0072 A79-14689  
Steam raising with low-Btu gas generators and potential for other applications 21 p0072 A79-14690  
Federal automobile fuel economy standards - A status report 21 p0073 A79-14693

- Building energy standards and codes 21 p0073 A79-14696
- Quantification of energy resource consumption 21 p0073 A79-14701
- Economics and net energy analysis - Is a new analytical technique needed for energy decision making 21 p0074 A79-14706
- DOE programs in material development for fusion laser systems 21 p0082 A79-15137
- An introduction to ocean thermal energy conversion /OTEC/ power plants 21 p0091 A79-15869
- Storage as an energy strategy for utilities 21 p0093 A79-15891
- A commentary on a methodology for assessment of the environmental impact of the electrical power system within the Connecticut River Basin 21 p0093 A79-15893
- Commercialization of fluidized-bed combustion systems by the State of Ohio 21 p0096 A79-15923
- Hydrogen economy - An alternative 21 p0096 A79-15925
- Combined environments: Technology interrelations; Proceedings of the Twenty-fourth Annual Technical Meeting, Fort Worth, Tex., April 18-20, 1978 21 p0097 A79-16076
- Clean Air Act amendments of 1977 and the impact on control efforts 21 p0097 A79-16091
- Time, technology and capital - Do we have enough to solve the energy crisis 21 p0097 A79-16100
- Net energy analysis and environmental aspects for solar tower central receiver systems. I - Methodology 21 p0097 A79-16101
- A multivariate-utility approach for selection of energy sources 21 p0098 A79-16120
- A comparative analysis of three of ERDA's major R & D programs 21 p0099 A79-16121
- An economist looks at solar energy - The government's role 21 p0099 A79-16132
- Current solar applications and economics 21 p0099 A79-16134
- The economics and policy of alternative energy sources - A review 21 p0103 A79-16454
- Solar Thermal Electric Program 21 p0112 A79-16730
- Input-output method applied to energy planning 21 p0112 A79-16737
- Macro-energy model - Impact of public policy on technological development 21 p0113 A79-16741
- Energy systems: An analysis for engineers and policy makers --- Book 21 p0114 A79-17218
- Potential research problems in energy systems analysis 21 p0115 A79-17221
- Energy economics - A research analysis --- considering OPEC Cartel impact 21 p0115 A79-17222
- Energy and input-output analysis --- for predicting impact on U.S. economy 21 p0115 A79-17223
- Analysis of alternatives for U.S. international cooperation in solar energy 21 p0116 A79-17277
- Plans and prospects for solar energy utilisation in Malawi 21 p0117 A79-17285
- Energy balances as a means for the evaluation of solar energy in developing countries 21 p0118 A79-17290
- Impacts of the National Energy Plan on solar economics [CONF-771203-6] 21 p0118 A79-17294
- Experiments in solar space heating and cooling for moderately insolated regions 21 p0137 A79-17464
- A methodology for evaluating the worth of a new energy resource with particular reference to wind energy utilisation in rural areas 21 p0143 A79-17514
- The Koppelman process --- to upgrade lignite and some waste energy sources 21 p0145 A79-17634
- Synthetic fuels from coal 21 p0145 A79-17636
- Perspectives on energy: Issues, ideas, and environmental dilemmas /2nd edition/ --- Book 21 p0147 A79-17646
- A low energy scenario for the United States - 1975-2050 21 p0147 A79-17649
- Solar power satellites - An AIAA position paper 21 p0148 A79-17872
- National program for the development of commercial MHD [AIAA PAPER 79-0188] 21 p0157 A79-19587
- Accelerating the commercialization on new technologies --- free market operation of federal alternate energy sources programs [ASME PAPER 78-WA/TS-4] 21 p0164 A79-19849
- The need for closed service areas in a supply economy based on line networks --- for German gas and electric utilities 21 p0168 A79-20447
- Costing the satellite power system [AAS PAPER 78-166] 22 p0243 A79-21270
- Optimal decisions for long-term operation of hydropower systems 22 p0245 A79-21473
- Investigations of solar heat production for household heating in Turkey 22 p0253 A79-22265
- Energy and remote sensing applications 22 p0255 A79-22516
- The economics of geothermal energy development at the regional level 22 p0256 A79-22756
- A planning and information system for strategic energy policy assessment --- Book 22 p0259 A79-23600
- Structuring a small national or state solar energy program 22 p0262 A79-23751
- Geothermal energy in Imperial County, California - Environmental, socio-economic, demographic, and public opinion research conclusions and policy recommendations 22 p0265 A79-24046
- Prospects for solar heating and cooling in the United States 22 p0275 A79-25929
- Santa Clara Community Center Project, USA --- solar building 22 p0277 A79-25945
- Energy policy of the European Economic Community 22 p0282 A79-26403
- Fuels of the future. I --- demand and proposed sources 22 p0282 A79-26404
- Electricity - An indigenous transport fuel 22 p0292 A79-27898
- Energy, resources, and policy --- Book 22 p0304 A79-30175
- Uncoupling of economic growth and energy consumption - A new strategy of energy politics or only a new slogan 22 p0310 A79-30997
- The role of applied meteorology in the Canadian energy programme 22 p0317 A79-31414
- NRC solar monitoring program 22 p0318 A79-31419
- NRC's wind energy program 22 p0319 A79-31426
- The Prince Edward Island Wind Energy Program 22 p0319 A79-31427
- Energy management through energy conservation in buildings 22 p0320 A79-31431
- The Energy Research and Development Program of the United States 22 p0325 A79-31909
- Energy research and development - A U.K. view 22 p0325 A79-31910

## SUBJECT INDEX

## ENERGY POLICY CONTD

- Chemical production from waste carbon monoxide:  
Its potential for energy conservation  
[BHWL-2137] 21 p0170 N79-10179
- Methane generation from human, animal, and  
agricultural wastes  
[PB-276469/4] 21 p0171 N79-10240
- Biomass utilization in Minnesota  
[PB-282531/3] 21 p0171 N79-10241
- Indoor test for thermal performance evaluation on  
the Northrup concentrating solar collector  
[NASA-CR-150804] 21 p0172 N79-10515
- Preliminary design package for solar heating and  
hot water system  
[NASA-CR-150619] 21 p0173 N79-10520
- Thermal performance evaluation of the Calmac  
(liquid) solar collector  
[NASA-CR-150819] 21 p0173 N79-10521
- Design package for concentrating solar collector  
panels  
[NASA-CR-150788] 21 p0173 N79-10523
- Rankine cycle machines for solar cooling  
[NASA-TM-78196] 21 p0173 N79-10524
- Net energy analysis of five energy systems  
[ORAU/IEA(R)-77-12] 21 p0174 N79-10534
- Geothermal Reservoir Engineering Management  
Program Plan (GREMP Plan)  
[LBL-7000] 21 p0174 N79-10536
- National coal utilization assessment: An  
integrated assessment of increased coal use in  
the midwest: Impacts and constraints, volume 1  
[ANL/AA-11-VOL-1-DRAFT] 21 p0174 N79-10537
- System for projecting the utilization of renewable  
resources. SPURR methodology  
[ERHC/2322-77/4] 21 p0174 N79-10538
- Hot dry rock energy project  
[LA-UR-77-2744] 21 p0175 N79-10540
- Energy availabilities for state and local  
development: 1973 data volume  
[ORNL/TM-5890-S2] 21 p0175 N79-10541
- Fluidized-bed combustion test of low-quality  
fuels: Texas lignite and lignite refuse  
[NERC/RI-78/3] 21 p0175 N79-10543
- Status of the DOE photovoltaic concentrator  
technology development project  
[SAND-78-0948C] 21 p0176 N79-10550
- Improved Conversion Efficiency Workshop. Volume 2:  
Summary  
[CONF-771003-P2-VOL-2] 21 p0176 N79-10551
- Energy conservation: Policies, programs and  
general studies. A bibliography with abstracts  
[NTIS/PS-78/0693/8] 21 p0176 N79-10552
- Energy in transportation  
[PB-282928/1] 21 p0177 N79-10561
- Energy: The new economic development wildcard  
[PB-282494/4] 21 p0177 N79-10564
- Comprehensive overview of winter energy data  
bulletins  
[PB-282787/1] 21 p0177 N79-10565
- Environmental control technology activities of the  
Department of Energy in FY 1977  
[DOE/EV-0030] 21 p0178 N79-10572
- Applications of thermal energy storage to process  
heat and waste heat recovery in the iron and  
steel industry  
[NASA-CR-159397] 21 p0183 N79-11473
- Program THER energy production units of average  
power and using thermal conversion of solar  
radiation  
[NASA-TM-75369] 21 p0183 N79-11474
- Thermal storage for industrial process and reject  
heat  
[NASA-TM-78994] 21 p0183 N79-11481
- Transportation Energy Conservation Data Book,  
edition 2  
[ORNL-5320] 21 p0184 N79-11487
- Energy information data base. Guide to  
abstracting and indexing  
[TID-4583-R1] 21 p0184 N79-11488
- Guide to reducing energy-use budget costs  
[HCP/U60505-01] 21 p0184 N79-11489
- Augmented solar energy collection using various  
planar reflective surfaces: Theoretical  
calculations and experimental results  
[LA-7041] 21 p0185 N79-11494
- Annual highlights of the energy technology programs  
[BNL-50799] 21 p0185 N79-11499
- Energy needs, uses, and resources in developing  
countries  
[BNL-50784] 21 p0185 N79-11500
- Solar heating and cooling demonstration project  
summaries  
[DOE/CS-0009] 21 p0186 N79-11503
- Bioinert approach to solar energy conversion:  
Artificial photosynthesis  
[CONF-780222-5] 21 p0186 N79-11506
- Advanced secondary batteries for electric vehicle  
propulsion  
[CONF-780426-2] 21 p0186 N79-11508
- Need for and deployment of inexhaustible energy  
resource technologies: Report of Technology  
Study Panel inexhaustible energy resources study  
[TID-28202] 21 p0186 N79-11510
- Energy availabilities for state and local  
development: Projected energy patterns for 1980  
and 1985  
[ORNL/TM-5890/54] 21 p0186 N79-11511
- Energy analysis  
[NP-23145] 21 p0187 N79-11513
- National Geothermal Information Resource  
[LBL-7803] 21 p0187 N79-11515
- High performance GaAs photovoltaic cells for  
concentrator applications  
[SAND-78-7018] 21 p0187 N79-11521
- Environmental Development Plan (EDP): Solar  
thermal power systems, 1977  
[DOE/EDP-0004] 21 p0187 N79-11522
- Fixed mirror solar concentrator for power generation  
[GA-A-14883] 21 p0187 N79-11526
- Effect of solar cell parameter variation on array  
power output  
[SAND-78-0917C] 21 p0188 N79-11527
- Energy situation in the Mid-Atlantic region  
[BNL-50703] 21 p0188 N79-11528
- Development of high-efficiency P(+)-N-N(+)   
back-surface-field silicon solar cells  
[SAND-78-1156C] 21 p0188 N79-11529
- Environmental Development Plan (EDP): Ocean  
thermal energy conversion, 1977  
[DOE/EDP-006] 21 p0188 N79-11531
- Energy and the economy  
[EPRI-EA-620-VOL-1] 21 p0189 N79-11539
- Federal Energy Data System (FEDS) technical  
documentation  
[PB-281815/1] 21 p0189 N79-11542
- The Federal Government should establish and meet  
energy conservation goals  
[PB-283066/9] 21 p0190 N79-11546
- Application of solar technology to today's energy  
needs, volume 1  
[PB-283770/6] 21 p0190 N79-11548
- Energy policy and research planning, volume 2. A  
bibliography with abstracts  
[NTIS/PS-78/0961/9] 21 p0191 N79-11552
- Energy policy and research planning, volume 3. A  
bibliography with abstracts  
[NTIS/PS-78/0962/7] 21 p0191 N79-11553
- Energy programs at The Johns Hopkins University  
Applied Physics Laboratory  
[PB-283171/7] 21 p0191 N79-11554
- Renewable ocean energy sources. Part 1: Ocean  
thermal energy conversion  
[PB-283104/8] 21 p0191 N79-11556
- Renewable ocean energy sources. Part 1: Working  
papers. Ocean thermal energy conversion  
[PB-283103/0] 21 p0191 N79-11557
- Committee on the challenges of modern society  
rational use of energy pilot study modular  
integrated utility system project. Volume 2:  
Minutes of project meeting  
[PB-283429/9] 21 p0191 N79-11558
- Potential producibility and recovery of natural  
gas from geopressured aquifers of the Cenozoic  
sediments of the Gulf Coast Basin  
[FE-2025-3] 21 p0192 N79-11607
- Parameters for legislative consideration of  
bioconversion technologies  
[PB-284742/4] 21 p0194 N79-12250
- Characterization of solar cells for space  
applications. Volume 4: Electrical  
characteristics of Spectrolab BSP 200-micron  
Helios cells as a function of intensity and  
temperature  
[NASA-CR-157934] 21 p0195 N79-12543
- Microprocessor control of a wind turbine generator  
[NASA-TM-79021] 21 p0195 N79-12548
- Prototype solar heating and cooling systems  
[NASA-CR-150828] 21 p0196 N79-12552

- MSPC hot air collectors  
[NASA-TM-78206] 21 p0196 N79-12556
- US Navy energy plan and program, 1978  
[AD-A058054] 21 p0197 N79-12560
- Array energy plan  
[AD-A057987] 21 p0197 N79-12562
- The department of Defense's alternate energy policy  
[AD-A058200] 21 p0197 N79-12563
- Solar Total Energy Test Facility project test results: High-temperature thermocline storage subsystem  
[SAND-77-1528] 21 p0197 N79-12565
- Energy information data base: Serial titles  
[TID-4579-R10] 21 p0197 N79-12566
- National photovoltaic program plan  
[DOE/ET-0035 (78)] 21 p0197 N79-12567
- Thermal stress cracking and the enhancement of heat extraction from fractured geothermal reservoirs  
[LA-7235-MS] 21 p0198 N79-12568
- Energy supply and environmental impacts: Conventional sources, study module 3-A, technical appendix  
[PB-283787/0] 21 p0198 N79-12573
- A Kentucky energy resource utilization program  
[PB-283796/1] 21 p0198 N79-12574
- Energy and environment: An intergovernmental perspective  
[PB-283733/4] 21 p0198 N79-12575
- Energy future Northwest: Northwest Energy Policy project  
[PB-284697/0] 21 p0199 N79-12578
- The energy dilemma: A challenge for Maryland. Proceedings Maryland General Assembly/AISLE Conference  
[PB-284703/6] 21 p0199 N79-12579
- Technical and environmental aspects of oil shale processing  
21 p0199 N79-12581
- Industrialization study --- impact of government incentives and barriers on decision making in the industrial production of photovoltaics  
[NASA-CR-157953] 21 p0200 N79-12970
- Status of alcohol fuels utilization technology for highway transportation  
[HCP/H2923-01] 21 p0201 N79-13190
- Technical notes for the conceptual design for an atmospheric fluidized-bed direct combustion power generating plant  
[HCP/T2583-01/2] 21 p0203 N79-13280
- Impact of electric passenger automobiles on utility system loads, 1985 - 2000  
[EPRI-EA-623] 21 p0203 N79-13281
- Application of multispectral scanner data to the study of an abandoned surface coal mine  
[NASA-TM-78912] 21 p0204 N79-13472
- A synoptic description of coal basins via image processing  
[NASA-CR-157970] 21 p0204 N79-13474
- Instrumentation at the Decade 80 solar house in Tucson, Arizona  
[NASA-CR-150851] 21 p0204 N79-13491
- Large hot water system long range thermal performance test report, addendum  
[NASA-CR-150842] 21 p0204 N79-13492
- Long-term weathering effects on the thermal performance of the Lennox/Honeywell (liquid) solar collector  
[NASA-CR-150818] 21 p0204 N79-13493
- Libbey-Owens-Ford solar collector static load test  
[NASA-CR-150852] 21 p0205 N79-13494
- Prototype solar-heated hot water systems and double-walled heat exchangers  
[NASA-CR-150854] 21 p0205 N79-13495
- Prototype solar heating and cooling systems including potable hot water  
[NASA-CR-150850] 21 p0205 N79-13498
- SIMS prototype system 4 - performance test report  
[NASA-CR-150820] 21 p0205 N79-13499
- LARGO hot water system thermal performance test report  
[NASA-CR-150841] 21 p0205 N79-13500
- Parametric study of two planar high power flexible solar array concepts  
[NASA-CR-157841] 21 p0205 N79-13501
- Industrial international data base: Energy analysis methodology. Rational use of energy program pilot study  
[NATO/CCMS-75] 21 p0206 N79-13508
- The definition of a national program in energy-efficient pump utilization, volume 1  
[HCP/W1260-01/1] 21 p0207 N79-13514
- The definition of a national program in energy-efficient pump utilization. Volume 2: Appendices  
[HCP/W1260-01/2] 21 p0207 N79-13515
- Program information notice --- technologies relevant to u.s. electric energy systems  
[DOE/ET-0059] 21 p0207 N79-13517
- Solar thermal power systems program: Program summary  
[DOE/ET-0018/1] 21 p0207 N79-13518
- Verification methodology for the DOE-1 building energy analysis computer program  
[LA-UR-78-1493] 21 p0208 N79-13520
- Component-based simulator for solar systems  
[LA-UR-78-1494] 21 p0208 N79-13521
- Concentrating solar collector test results, Collector Module Test Facility  
[SAND-78-0815] 21 p0208 N79-13522
- Energy systems studies program  
[BNL-50822] 21 p0209 N79-13526
- Optical design of a solar collector for the advanced solar thermal electric conversion/process heat program  
[Y/SUB-77/14261] 21 p0209 N79-13528
- Photovoltaic program: Program summary  
[DOE/ET-0019/1] 21 p0209 N79-13529
- Solar Irrigation Program Data Base Management System (SIPDBMS)  
[SAND-78-0641] 21 p0209 N79-13532
- Solar energy  
[DOE/ET-0062] 21 p0210 N79-13535
- Planning program to accelerate energy conservation in municipalities  
[HCP/M05017-01/1] 21 p0210 N79-13536
- Analysis of federal incentives used to stimulate energy production  
[PNL-2410] 21 p0210 N79-13539
- Solar pilot plant, phase 1  
[SAN/1109-77-7] 21 p0210 N79-13542
- Energy scenarios: Supplementary studies  
[NP-23292] 21 p0211 N79-13543
- Candidate chemical systems for air cooled, solar powered, absorption air conditioner design. Part 2: Solid absorbents, high latent heat refrigerants  
[SAN/1587-2] 21 p0211 N79-13544
- EPA program status report: Oil shale  
[PB-284480/1] 21 p0211 N79-13548
- Solar space heating and air conditioning, volume 2. Citations from the engineering index data base  
[NTIS/PS-78/1016/1] 21 p0212 N79-13550
- Flat plate solar collector design and performance. Citations from the NTIS data base  
[NTIS/PS-78/0840/5] 21 p0212 N79-13551
- An annotated compilation of the sources of information related to the usage of electricity in non-industrial applications  
[PB-285260/6] 21 p0212 N79-13552
- Environmental control implications of generating electric power from coal. Appendix A, part 2: Coal preparation and cleaning assessment study appendix  
[ANL/ECT-3-APP-A-PT-2] 21 p0213 N79-13571
- Assessment of the solid waste impact of the National Energy Plan  
[BNL-50708] 21 p0213 N79-13572
- Requirements for environmental monitoring assessment, and controls for nonnuclear energy demonstration projects. Report to Congress, prepared in fulfillment of Public Law 95-39, section 113  
[DOE/EV-0014] 21 p0213 N79-13573
- Coal loan guarantee program (PL 94-163)  
[DOE/EIS-0004] 21 p0213 N79-13574
- Proposed standby gasoline rationing plan. Economic and regulatory analysis draft  
[DOE/EBA-0009] 21 p0214 N79-13934
- Accuracy analysis of pointing control system of solar power station  
[NASA-CR-150880] 21 p0215 N79-14143
- Primary reflector for solar energy collection systems  
[NASA-CASE-NPO-13579-4] 21 p0217 N79-14529
- Preliminary economic analysis of Solar Irrigation Systems (SIS) for selected locations  
[SAND-77-1403] 21 p0220 N79-14566

# SUBJECT INDEX

# ENERGY REQUIREMENTS

Thermochemical energy storage and transport program  
[SAND-78-8056] 21 p0221 N79-14570

Recommendations for the conceptual design of the  
Barstow, California, solar central receiver  
pilot plant: Executive summary  
[SAND-77-8035] 21 p0221 N79-14571

Energy information: Report to Congress  
[NTISUB/C/027-001] 21 p0221 N79-14576

Harnessing tidal energy  
[PB-286671/3] 21 p0222 N79-14581

Water related constraints in energy production  
[PB-285713/4] 21 p0222 N79-14582

Region at the crossroads: The Pacific Northwest  
searches for new sources of electric energy  
[PB-284691/3] 21 p0222 N79-14583

The ground water and energy supply situation for  
Great Plains irrigation  
[PB-286002/1] 21 p0222 N79-14586

Summary of atmospheric wind design criteria for  
wind energy conversion system development  
[NASA-TP-1389] 21 p0223 N79-14678

Development of an Air Force facilities energy  
information system  
[AD-A059309] 21 p0223 N79-14918

Engineering and economic analysis of waste to  
energy systems  
[PB-285797/7] 21 p0224 N79-14946

The 25 kw power module updated baseline system ---  
for space transportation system payloads  
[NASA-TM-78212] 21 p0226 N79-15247

Remote monitoring of coal strip mine rehabilitation  
[PB-286647/3] 21 p0228 N79-15379

The national energy plan: Options under  
assumptions of national security threat ---  
economic impact procurement policy, and  
resources management  
[H-PRINT-95-48] 21 p0228 N79-15398

The national energy plan: Options under  
assumptions of national security threat or  
energy policy as if it really mattered  
[H-PRINT-95-42] 21 p0228 N79-15399

US energy demand and supply, 1976-1985: Limited  
options, unlimited constraints  
[H-PRINT-95-43] 21 p0228 N79-15400

Passive thermosyphon solar heating and cooling  
module with supplementary heating  
[NASA-CR-150849] 21 p0229 N79-15402

Comparison of fuel-cell and diesel integrated  
energy systems and a conventional system for a  
500-unit apartment  
[NASA-TM-79037] 21 p0229 N79-15403

Design data brochure for the Owens-Illinois Sunpak  
(TM) air-cooled solar collector  
[NASA-CR-150868] 21 p0229 N79-15404

Solar hot water system installed at Anderson,  
South Carolina  
[NASA-CR-150856] 21 p0229 N79-15405

Solar heating and hot water system installed at  
Listerhill, Alabama  
[NASA-CR-150870] 21 p0229 N79-15406

Preliminary design package for prototype solar  
heating and cooling systems  
[NASA-CR-150853] 21 p0229 N79-15409

Energy conservation and the rural home: Economic  
considerations for the nation and the individual  
[PB-286222/5] 21 p0230 N79-15425

Energy education training: Feasibility study  
[PB-285910/6] 21 p0230 N79-15428

Amended Oregon State energy conservation plan,  
1978 Prepared in response to the Energy Policy  
and Conservation Act of 1975 (PL 94-163), and  
the Energy Conservation and Production Act of  
1976 (PL 94-385)  
[PB-286078/1] 21 p0231 N79-15430

The impact of energy resource development on water  
resource allocations  
[PB-286135/9] 21 p0231 N79-15432

Coal research: Data systems and information  
transfer  
[ORAU-133] 21 p0232 N79-15830

Phase one/base data for the development of energy  
performance standards for new buildings: Sample  
design  
[PB-286903/0] 22 p0331 N79-16150

Energy and economic analysis of industrial process  
heat recovery with heat pumps  
22 p0331 N79-16210

Northern Alaska hydrocarbon resources  
[PB-287394/1] 22 p0332 N79-16342

Phase one/base data for the development of energy  
performance standards for new buildings.  
Climatic classification  
[PB-286900/6] 22 p0336 N79-16497

Direction of gas supply research in the US  
22 p0340 N79-17320

Energy today and tomorrow  
22 p0341 N79-17326

Energy conservation: Policy issues and end-use  
scenarios of savings potential. Part 1: Summary  
[LBL-7896] 22 p0341 N79-17329

Research and development needs to merge  
environmental and energy objectives  
[GPO-23-254] 22 p0342 N79-17339

Water/energy management and evaluation model for  
Pennsylvania  
[PB-287577/1] 22 p0343 N79-17353

Life-cycle costing. A guide for selecting energy  
conservation projects for public buildings ---  
computing the cost effectiveness of retrofitting  
and new buildings  
[PB-287804/9] 22 p0345 N79-17744

Energy environment III  
[EPA-600/9-78-022] 22 p0346 N79-18352

Identification of wood energy resources in central  
Michigan  
[NASA-CR-158130] 22 p0347 N79-18424

Buildings energy use data book, edition 1  
[ORNL-5363] 22 p0348 N79-18447

Block 4 solar cell module design and test  
specification for residential applications  
[NASA-CR-158117] 22 p0348 N79-18453

Installation package for a solar heating system  
[NASA-CR-150876] 22 p0349 N79-18454

Resource analysis: Water and energy as linked  
resources  
[PB-288046/6] 22 p0349 N79-18463

The development of a laser Doppler velocimetry  
system for unsteady separated flow research:  
Preliminary results  
[AD-A061724] 22 p0352 N79-19305

Energy analyses applied to ocean thermal energy  
conversion and an offshore wind power system  
22 p0353 N79-19442

The good news about energy  
22 p0355 N79-19461

Phase one/base data for the development of energy  
performance standard for new buildings. Task  
report: Building classification  
[PB-286904/8] 22 p0355 N79-19468

Cost analysis and optimization study for solar  
heating and cooling systems, Stillwater,  
Minnesota and Newcastle, Pennsylvania  
[NASA-CR-161201] 22 p0358 N79-20478

Thermal power systems point-focusing distributed  
receiver technology project. Volume 1:  
Executive summary  
[NASA-CR-158421] 22 p0360 N79-20492

Thermal storage technologies for solar industrial  
process heat applications  
[NASA-TM-79130] 22 p0360 N79-20498

Cost analysis and optimization study for solar  
heating and cooling systems  
[NASA-CR-161200] 22 p0360 N79-20499

Venture analysis case study for on-site fuel cell  
energy systems  
[PCR-0783-VOL-1] 22 p0361 N79-20505

Measuring energy conservation  
[DOE/EIA-0103/18] 22 p0362 N79-20509

Economic impacts of a transition to higher oil  
prices --- estimation and budget allocations  
[BNL-50871] 22 p0364 N79-20927

Development, testing, and certification of  
Owens-Illinois model SEC-601 solar energy  
collector system  
[NASA-TM-78223] 22 p0371 N79-21620

Energy conservation through source reduction  
[PB-290126/2] 22 p0372 N79-21626

**ENERGY REQUIREMENTS**

Advanced wind furnace systems for residential and  
agricultural heating and electrical supply  
applications  
21 p0028 A79-10237

Toroidal Accelerator Rotor Platforms for wind  
energy conversion  
21 p0029 A79-10240

Energy efficiency in the transport sector  
21 p0054 A79-13574

## ENERGY SOURCES

Fuel cell on-site integrated energy system  
parametric analysis of a residential complex  
21 p0081 A79-14947

Market penetration for OTEC  
21 p0094 A79-15903

Energy utilization analysis of buildings  
21 p0103 A79-16462

Input-output method applied to energy planning  
21 p0112 A79-16737

Energy requirements of a limestone PGD system ---  
Flue Gas Desulfurization  
21 p0114 A79-16747

A low energy scenario for the United States -  
1975-2050  
21 p0147 A79-17649

Energy requirements of the rail mode  
[ASME PAPER 78-RT-1]  
21 p0150 A79-18085

Modeling energy and power requirements of electric  
vehicles  
21 p0153 A79-18465

Heat pulses required to quench a potted  
superconducting magnet  
22 p0236 A79-20538

Historical and projected power requirements  
21 p0169 N79-10125

An economical approach to space power systems  
21 p0170 N79-10139

Energy needs, uses, and resources in developing  
countries  
[BNL-50784]  
21 p0185 N79-11500

Energy use patterns for metal recycling  
[PB-284855/4]  
21 p0201 N79-13152

Some measures of regional-industrial interfuel  
substitution potentials  
[BNL-24368]  
21 p0208 N79-13525

Pulsed power supplied for large laser systems  
[UCRL-80113]  
21 p0217 N79-14377

Calculation of backup requirements  
21 p0218 N79-14533

Energy requirements of present pollution control  
technology  
[PB-286231/6]  
21 p0223 N79-14643

US energy demand and supply, 1976-1985: Limited  
options, unlimited constraints  
[H-PRINT-95-43]  
21 p0228 N79-15400

Energy and the economy: The economic impact of  
alternative energy supply-demand assumptions  
[H-PRINT-95-51]  
22 p0333 N79-16352

Energy requirements for producing steel in the  
Republic of South Africa  
22 p0340 N79-17322

Energy conservation: Policy issues and end-use  
scenarios of savings potential. Part 1: Summary  
[LBL-7896]  
22 p0341 N79-17329

The world balance for energy needs in view of year  
2000: Development of the problem and areas  
involved, part 2  
[BLI-RISLEY-TR-3395-(9091.9P)]  
22 p0347 N79-18442

Bioconversion study conducted by JPL  
[NASA-CR-158228]  
22 p0354 N79-19450

### ENERGY SOURCES

A theoretical method for the prediction of monthly  
mean solar radiation parameters  
21 p0022 A79-10183

The utilization of European space techniques for  
energy production  
[IAF PAPER 78-190]  
21 p0035 A79-11287

Low-grade thermal energy-conversion Joule effect  
heat engines  
[ASME PAPER 78-ENAS-7]  
21 p0048 A79-12556

Potential and technical utilization of renewable  
energy sources  
21 p0058 A79-13655

The wind as a potential energy source in future  
hydrogen technology  
21 p0059 A79-13661

Saudi Arabia looks at the sun  
21 p0063 A79-13900

A survey of energy information systems and its  
implications for industrial energy management  
21 p0072 A79-14685

Forest residues as an alternate energy source  
21 p0072 A79-14689

A systems study of our energy problems  
21 p0074 A79-14704

Economics and net energy analysis - Is a new  
analytical technique needed for energy decision  
making  
21 p0074 A79-14706

## SUBJECT INDEX

Wind, waves, and tides --- as future energy sources  
21 p0074 A79-14719

Conservation as an energy source  
21 p0077 A79-14769

Energy sources and conventional magnets --- for  
tokamak experiment Power Reactor toroidal field  
21 p0079 A79-14791

Source emissions factors for refuse derived fuels  
21 p0082 A79-15084

Hot dry rock - A new geothermal energy source  
21 p0087 A79-15673

History of solar energy applications - Solar  
energy yesterday, today and tomorrow  
21 p0089 A79-15852

Time, technology and capital - Do we have enough  
to solve the energy crisis  
21 p0097 A79-16100

A multivariate-utility approach for selection of  
energy sources  
21 p0098 A79-16120

A comparative analysis of three of ERDA's major R  
& D programs  
21 p0099 A79-16121

Solar electricity production  
21 p0104 A79-16467

The effects of different energy strategies on the  
atmospheric CO2 concentration and climate  
21 p0106 A79-16523

The impact of advanced technology on the future  
electric energy supply problem  
21 p0112 A79-16736

Input-output method applied to energy planning  
21 p0112 A79-16737

Urban wastes as an energy source  
21 p0115 A79-17220

Sun: Mankind's future source of energy;  
Proceedings of the International Solar Energy  
Congress, New Delhi, India, January 16-21, 1978.  
Volumes 1, 2 & 3  
21 p0116 A79-17276

Prospects for harnessing renewable energy sources  
in developing countries  
21 p0117 A79-17286

Cost of solar energy  
21 p0118 A79-17291

A methodology for evaluating the worth of a new  
energy resource with particular reference to  
wind energy utilization in rural areas  
21 p0143 A79-17514

The Koppelman process --- to upgrade lignite and  
some waste energy sources  
21 p0145 A79-17634

Perspectives on energy: Issues, ideas, and  
environmental dilemmas /2nd edition/ --- Book  
21 p0147 A79-17646

Wind power and other energy options --- Book  
21 p0153 A79-18346

Underground gasification of coal at deep levels -  
Perspectives and problems  
21 p0156 A79-19401

Accelerating the commercialization on new  
technologies --- free market operation of  
federal alternate energy sources programs  
[ASME PAPER 78-WA/TS-4]  
21 p0164 A79-19849

Wind power potential in the Pacific Northwest  
22 p0244 A79-21334

Recent advances in Na/S cell development - A review  
22 p0246 A79-21488

Energy for the long run - Fission or fusion  
22 p0256 A79-22760

A theoretical study of wood gasification processes  
22 p0257 A79-22923

Optimizing the conversion mode for solar energy  
22 p0258 A79-23125

East Mesa geothermal test site  
22 p0259 A79-23458

A fundamental model for the evolution of a  
two-phase geothermal reservoir with application  
to environmental impact analysis  
22 p0263 A79-23777

Risk with energy from conventional and  
nonconventional sources  
22 p0266 A79-24151

Energy for Europe from space  
22 p0273 A79-25605

Energy development --- for future global demand  
22 p0282 A79-26402



# SUBJECT INDEX

# ENERGY STORAGE

- Fuels of the future. I --- demand and proposed sources 22 p0282 A79-26404
- Limits to wind power utilization 22 p0302 A79-29601
- The impact of alternate energy resources on the future supply of electric power [IEEE PAPER P 78 672-8] 22 p0304 A79-29939
- Energy, resources, and policy --- Book 22 p0304 A79-30175
- Two-dimensional analyses related to wave-energy extraction by submerged resonant ducts 22 p0312 A79-31099
- Renewable alternatives; Proceedings of the Fourth Annual Conference, University of Western Ontario, London, Canada, August 20-24, 1978. Volumes 1 & 2 22 p0316 A79-31401
- The Energy Research and Development Program of the United States 22 p0325 A79-31909
- Solar energy - Four sites demonstrate potential 22 p0328 A79-32194
- Energy availabilities for state and local development: 1973 data volume [ORNL/TM-5890-S2] 21 p0175 A79-10541
- Energy availabilities for state and local development: 1974 data volume [ORNL/TM-5890-S3] 21 p0175 A79-10542
- Projects to expand energy sources in the western states [PB-283706/0] 21 p0190 A79-11547
- Future aviation fuels fuel suppliers views 21 p0202 A79-13194
- Symposium on Energy Today and Tomorrow [CSIR-S-145] 22 p0340 A79-17316
- Resource analysis: Water and energy as linked resources [PB-288046/6] 22 p0349 A79-18463
- Public hearing transcript: Federal non-nuclear energy research and development program [PB-287910/4] 22 p0349 A79-18464
- Thermal power systems point-focusing distributed receiver technology project. Volume 1: Executive summary [NASA-CR-158421] 22 p0360 A79-20492
- ENERGY STORAGE**
- A new power cycle that combines power generation with energy storage 21 p0004 A79-10040
- A critical review and evaluation of published electric-vehicle performance data 21 p0009 A79-10081
- High efficiency thermal energy storage system for utility applications 21 p0012 A79-10102
- Recent advances in thermochemical energy storage and transport 21 p0012 A79-10104
- A thermochemical energy storage system and heat pump 21 p0012 A79-10105
- NaOH-based high temperature heat-of-fusion thermal energy storage device 21 p0012 A79-10106
- Form-stable, crystalline polymer pellets for thermal energy storage 21 p0013 A79-10107
- Storage systems for solar thermal power 21 p0013 A79-10108
- Ejector augmentation of the air supply in a compressed air energy storage plant 21 p0013 A79-10109
- Laboratory evaluation of a composite flywheel energy storage system 21 p0013 A79-10110
- A method for the comparative economic assessment of storage systems 21 p0013 A79-10111
- Energy distribution and storage alternates with a centralized heat source 21 p0013 A79-10112
- Progress report on hydrogen production and utilization for community and automotive power 21 p0016 A79-10132
- Liquid desiccant solar air conditioner and energy storage system 21 p0021 A79-10176
- SINWEST - A simulation model for wind energy storage systems 21 p0029 A79-10241
- The propulsion of vehicles by a flywheel 21 p0031 A79-10452
- Symposium on Electrode Materials and Processes for Energy Conversion and Storage, Philadelphia, Pa., May 9-12, 1977, Proceedings 21 p0036 A79-11776
- Semiconductor electrodes for conversion and storage of solar energy 21 p0036 A79-11777
- Hydrogen storage by LaNi5 - Fundamentals and applications 21 p0038 A79-11803
- Absorption of hydrogen by the intermetallics NdNi5 and LaNi4Cu and a correlation of cell volumes and desorption pressures 21 p0038 A79-11804
- New alloy systems for hydrogen storage 21 p0038 A79-11806
- Batteries for transportation and load-leveling applications 21 p0041 A79-11837
- A practical electrochemical transport equation for non-dilute solutions --- for energy storage application 21 p0041 A79-11841
- The ion fly-wheel effect on the electro-thermal instability in non-equilibrium MHD Hall disc generators 21 p0046 A79-12270
- Solar thermal energy storage using heat of dilution - Analysis of heat generation in multistage mixing column 21 p0046 A79-12271
- Selection of method for calculating the parameters of wind and solar power station storage facilities 21 p0054 A79-13293
- Metal hydride solar heat pump and power system /HYCSOS/ [AIAA PAPER 78-1762] 21 p0061 A79-13863
- Modelling energy storage systems for electric utility applications Preliminary considerations 21 p0081 A79-14960
- Storage as an energy strategy for utilities 21 p0093 A79-15891
- Materials problems in solar, nuclear and storage of energy 21 p0094 A79-15901
- Thermal storage of solar energy 21 p0103 A79-16459
- Solar thermal conversion 21 p0104 A79-16466
- Application of electron beams in space for energy storage and optical beam generation 21 p0108 A79-16606
- Energy '78; Annual Conference, Tulsa, Okla., April 16-18, 1978, Record of Conference Papers 21 p0111 A79-16726
- Energy storage for tokamak reactor cycles --- during downtime for periodic plasma quench and reignition 21 p0111 A79-16727
- Flywheel energy storage system for JT-60 toroidal field coil 21 p0112 A79-16729
- Bibliographic and numeric data bases for fiber composites and matrix materials 21 p0114 A79-16984
- Energy storage requirements for autonomous and hybrid solar thermal electric power plants 21 p0120 A79-17315
- Mechanical energy storage system for a 10 KWe solar power pack 21 p0121 A79-17329
- Direct photoelectrochemical conversion and storage of solar energy 21 p0126 A79-17370
- Some studies on an experimental solar pond 21 p0131 A79-17416
- Optimal control of on-board and station flywheel storage for rail transit systems 21 p0148 A79-17822
- Energy storage by the use of high temperature electrochemical systems 21 p0148 A79-17992

# ENERGY STORAGE CONTD

# SUBJECT INDEX

Solar fuels --- photochemical reaction kinetics and energy storage 21 p0149 A79-18009

Properties optimization for phase-change energy storage in air-based solar heating systems 21 p0149 A79-18018

Studies in retining tidal energy 21 p0152 A79-18115

The role of tidal power stations in future scenarios for electricity storage in U.K. 21 p0152 A79-18116

Integrating wave power into the electricity supply system 21 p0152 A79-18117

Optimal control of on-board and station flywheel storage for rail transit systems [ASME PAPER 78-WA/DSC-32] 21 p0159 A79-19771

On vibration of a thick flexible ring rotating at high speed --- for flywheel energy storage 22 p0235 A79-20511

30-MJ superconducting magnetic energy storage /SMES/ unit for stabilizing an electric transmission system 22 p0237 A79-20555

Universal generator storer curves --- Economic and relative size optimization of solar photovoltaic energy 22 p0238 A79-20799

Flywheel energy accumulators for road vehicles 22 p0241 A79-20845

Current status of composite flywheel development 22 p0241 A79-20853

Energy storage requirements for spacecraft 22 p0246 A79-21486

Hydrides for energy storage; Proceedings of the International Symposium, Gellio, Norway, August 14-19, 1977 22 p0247 A79-21676

Survey of the different types of hydrides --- for hydrogen energy storage 22 p0247 A79-21678

Structural studies of hydrides by neutron diffraction 22 p0248 A79-21681

Localization and diffusion of hydrogen in lanthanum-nickel compounds 22 p0248 A79-21682

Nuclear magnetic resonance studies of metal hydrides 22 p0248 A79-21683

Electronic structure and physical properties of Ti-H and Zr-H using NMR 22 p0248 A79-21685

Electronic states of concentrated Pd-H alloys from de Haas-van Alphen measurements 22 p0248 A79-21686

Kinetics of hydrogen absorption and desorption --- for energy storage 22 p0248 A79-21687

The storage and release of hydrogen from magnesium alloy hydrides for vehicular applications 22 p0249 A79-21688

Calculated heats of formation of metal and metal alloy hydrides 22 p0249 A79-21690

Acoustic emissions during hydride formation 22 p0249 A79-21691

Magnetic and electrical properties of rare earth and rare earth intermetallic hydrides 22 p0249 A79-21692

Metal hydride electrodes for electrochemical energy storage 22 p0249 A79-21695

Hydrides of rare earth-nickel compounds - Structure and formation enthalpies 22 p0250 A79-21697

The use of FeTi-hydride for production and storage of suprapure hydrogen 22 p0250 A79-21700

Hydride formation of C14-type Ti alloy 22 p0250 A79-21701

Hydrogen sorption properties in binary and pseudobinary intermetallic compounds 22 p0250 A79-21702

The metallurgy and production of rechargeable hydrides --- for hydrogen storage 22 p0250 A79-21703

Hydrogen storage electrode systems 22 p0251 A79-21710

Hydrogen electrochemical storage by substituted LaH5 compounds 22 p0251 A79-21711

Mixing effects of two different types of hydrides --- phase behaviors and energy storage applications 22 p0251 A79-21714

Applications of metal hydrides --- emphasizing use as energy storage media 22 p0251 A79-21715

HYCSOS - A system for evaluation of hydrides as chemical heat pumps 22 p0252 A79-21716

The hydrogen/hydride energy concept 22 p0252 A79-21717

A hybrid chemical concept for solar energy storage 22 p0254 A79-22271

Storage tank efficiency as simulated in a Markovian model of meteorology 22 p0254 A79-22272

Energy storage efficiency for the ammonia/hydrogen-nitrogen thermochemical energy transfer system 22 p0261 A79-23718

Synthetic chloroplasts --- for photosynthetic solar energy conversion 22 p0262 A79-23721

Solar energy storage as hydrogen and bromine from hydrogen bromide 22 p0265 A79-24045

The effects of internal latent energy storage on the operational dynamics of a solar-powered absorption cycle 22 p0267 A79-24311

Storage peak gas-turbine power plant --- compressor for electric energy storage 22 p0268 A79-24507

Modeling the champagne effect in compressed air energy storage 22 p0280 A79-26190

Performance of a hydraulic air compressor for use in Compressed Air Energy Storage power systems 22 p0280 A79-26191

Analysis of energy storage by phase change with an array of cylindrical tubes 22 p0281 A79-26207

Heat transfer and calorimetric studies of a direct contact-latent heat energy storage system 22 p0281 A79-26210

Superbatteries - A progress report --- for utility energy storage and electric vehicles 22 p0286 A79-27207

An overview of the STOR hydrogen energy program 22 p0289 A79-27655

Air Force applications of lightweight superconducting machinery --- in airborne power sources 22 p0290 A79-27666

A general design method for closed-loop solar energy systems 22 p0295 A79-28359

Application of kinetic energy storage to transportation systems --- flywheels 22 p0299 A79-29337

A flywheel energy storage and conversion system for solar photovoltaic applications [ASME PAPER 79-SOL-1] 22 p0307 A79-30539

Hydrogen storage in FeTi - Surface segregation and its catalytic effect on hydrogenation and structural studies by means of neutron diffraction 22 p0312 A79-31156

Distributed energy storage for solar applications 22 p0317 A79-31410

Battery workshop 21 p0170 A79-10143

Rotatable mass for a flywheel [NASA-CASE-MPS-23051-1] 21 p0172 A79-10422

Thermal energy storage subsystems [NASA-CR-150812] 21 p0172 A79-10517

Hydrogen energy storage program: Five-year plan [DOE/ET-0046] 21 p0175 A79-10544

Study of flywheel energy storage Executive summary [PB-282652/7] 21 p0176 A79-10555

Study of flywheel energy storage. Volume 2: Systems analysis [PB-282653/5] 21 p0176 A79-10556

# SUBJECT INDEX

Study of flywheel energy storage. Volume 3:  
System mechanization  
[PB-282654/3] 21 p0177 N79-10557

Study of flywheel energy storage. Volume 4:  
Life-cycle costs  
[PB-282655/0] 21 p0177 N79-10558

Study of flywheel energy storage. Volume 5:  
Vehicle tests  
[PB-282656/8] 21 p0177 N79-10559

A study of flywheel energy storage for urban transit vehicles  
[PB-282929/9] 21 p0177 N79-10563

Applications of thermal energy storage to process heat and waste heat recovery in the iron and steel industry  
[NASA-CR-159397] 21 p0183 N79-11473

Supply of reactants for Redox bulk energy storage systems  
[NASA-TN-78995] 21 p0183 N79-11479

Preliminary design and analysis of a total energy system for Massachusetts Institute of Technology  
[AD-A057289] 21 p0184 N79-11486

Battery Energy Storage Test (BEST) Facility. Phenomenological cell modeling: A tool for planning and analyzing battery testing at the BEST facility  
[COO-2857-1] 21 p0184 N79-11490

Development of sodium-sulfur batteries for utility application  
[EPRI-EM-683] 21 p0186 N79-11502

Applied research on energy storage and conversion for photovoltaic and wind energy systems. Volume 3: Wind conversion systems with energy storage  
[HCP/T22221-01/3] 21 p0189 N79-11535

Evaluated physical properties data for materials used in energy storage systems  
[UCRL-81159] 21 p0189 N79-11536

Specific heat variations in oil energy storage media and their economic implications  
[SAND-78-8672] 21 p0189 N79-11537

Energy programs at The Johns Hopkins University Applied Physics Laboratory  
[PB-283171/7] 21 p0191 N79-11554

Energy programs at The Johns Hopkins University Applied Physics Laboratory  
[PB-283170/9] 21 p0191 N79-11555

A feasibility study of inorganic oxide-fluoride compositions for thermal energy storage applications  
[AD-A059001] 21 p0196 N79-12559

Solar Total Energy Test Facility project test results: High-temperature thermocline storage subsystem  
[SAND-77-1528] 21 p0197 N79-12565

An assessment of thermal energy storage and waste heat dissipation with total energy systems for MIT  
[AD-A059061] 21 p0205 N79-13502

Applied research on energy storage and conversion for photovoltaic and wind energy systems. Volume 2: Photovoltaic systems with energy storage  
[HCP/T22221-01/2-2] 21 p0207 N79-13510

Applied research on energy storage and conversion for photovoltaic and wind energy systems. Volume 1: Study summary and concept screening  
[HCP/T22221-01/1-VOL-1] 21 p0207 N79-13511

Stored energy calculation: The state of the art  
[PNL-2581] 21 p0210 N79-13541

Comparative properties of fiber composites for energy-storage flywheels part A. Evaluation of fibers for flywheel rotors --- Kevlar/epoxy and glass/epoxy composites  
[UCRL-80116-PT-A] 21 p0215 N79-14165

Lead-acid battery: An evaluation of commercialization strategies  
[MTR-7593] 21 p0220 N79-14565

Solar thermal test facility experiment manual  
[SAND-77-1173] 21 p0221 N79-14568

Thermochemical energy storage and transport program  
[SAND-78-8056] 21 p0221 N79-14570

Development of a high energy storage flywheel module  
[AD-A060351] 21 p0230 N79-15413

Bioconversion study conducted by JPL  
[NASA-CR-158228] 22 p0354 N79-19450

Thermal storage technologies for solar industrial process heat applications  
[NASA-TN-79130] 22 p0360 N79-20498

# ENERGY TECHNOLOGY

Thin film battery/fuel cell power generating system  
[CONS/1197-9] 22 p0369 N79-21556

Wayside energy storage summary. Volume 1: Summary  
[DOT-TSC-PRA-79-7-1-VOL-1] 22 p0370 N79-21563

The 25 KN space station 22 p0371 N79-21604

## ENERGY TECHNOLOGY

Intersociety Energy Conversion Engineering Conference, 13th, San Diego, Calif., August 20-25, 1978, Proceedings. Volumes 1, 2 & 3 21 p0001 A79-10001

Satellite power systems /SPS/ overview 21 p0002 A79-10022

Colorado's oil-shale resource for vertical modified in-situ processes 21 p0005 A79-10046

Comparison of shale oils from different sources produced by controlled-state retort 21 p0005 A79-10047

Permeability enhancement using explosive techniques --- georesources recovery techniques 21 p0005 A79-10048

Design considerations for an in situ gasification test of eastern bituminous coals 21 p0005 A79-10049

Underground thermal generation of hydrocarbons from dry, southwestern coals 21 p0005 A79-10050

Status of the DOE underground coal conversion program 21 p0005 A79-10052

Operation of the Ft. Lewis, Washington Solvent Refined Coal /SRC/ Pilot Plant in the SRC I and SRC II processing modes 21 p0006 A79-10054

Coal conversion by flash hydropyrolysis and hydrogasification 21 p0006 A79-10055

Synthane - A process for the gasification of caking and noncaking coals 21 p0006 A79-10057

Process development for the Westinghouse advanced fluidized-bed coal gasification system 21 p0006 A79-10058

Gasification of coal liquefaction residues 21 p0006 A79-10059

Exxon Donor Solvent coal liquefaction process development 21 p0007 A79-10060

Exploratory research in coal conversion 21 p0007 A79-10061

Coal liquefaction - Status and new directions 21 p0007 A79-10062

Novel technology for conversion of methanol and synthesis gas to hydrocarbons 21 p0007 A79-10064

Alternatives for coal based power generation - An international overview 21 p0008 A79-10074

Fossil superheating in geothermal steam power plants 21 p0014 A79-10122

Heat exchanger design for geothermal power plants 21 p0015 A79-10123

Hydrogen production from high temperature electrolysis and fusion reactor 21 p0015 A79-10126

Progress report on hydrogen production and utilization for community and automotive power 21 p0016 A79-10132

Preliminary design of the solar total energy-large scale experiment at Shenandoah, Georgia 21 p0019 A79-10159

Conceptual design of the Fort Hood Solar Total Energy-Large Scale Experiment 21 p0019 A79-10160

JPL - Small Power Systems Applications Project --- for solar thermal power plant development and commercialization 21 p0019 A79-10161

Enhanced solar energy options using earth-orbiting mirrors 21 p0019 A79-10162

Design, construction, and testing of a Fixed Mirror Solar Concentrator field 21 p0020 A79-10164

Design of a preprototype Stirling Laboratory Research Engine 21 p0024 A79-10203

- The matching of a free piston Stirling engine coupled with a free piston linear compressor for a heat pump application 21 p0024 A79-10204
- A Stirling engine heat pump system 21 p0024 A79-10206
- Experimental demonstration of the Diffuser Augmented Wind Turbine concept 21 p0029 A79-10238
- Symposium on Electrode Materials and Processes for Energy Conversion and Storage, Philadelphia, Pa., May 9-12, 1977, Proceedings 21 p0036 A79-11776
- Optics applied to solar energy conversion; Proceedings of the Seminar, San Diego, Calif., August 23, 24, 1977 21 p0042 A79-11965
- Coal desulfurization: Chemical and physical methods; Proceedings of the Symposium, New Orleans, La., March 23, 1977 21 p0044 A79-12114
- German Solar Energy Forum, 1st, Hamburg, West Germany, September 26-28, 1977, Proceedings. Volume 2 21 p0055 A79-13619
- Passive solar heating and cooling [AIAA PAPER 78-1756] 21 p0060 A79-13857
- Solar thermal power systems point-focusing distributed receiver /PPDR/ technology - A project description [AIAA PAPER 78-1771] 21 p0062 A79-13869
- Optimum selection of a wind turbine generator system [AIAA PAPER 78-1774] 21 p0062 A79-13871
- Design of a second generation concentrating tracking solar collector [AIAA PAPER 78-1775] 21 p0062 A79-13872
- Energy and the environment; Proceedings of the Fifth National Conference, Cincinnati, Ohio, November 1-3, 1977 21 p0063 A79-14106
- A standard procedure of economic evaluation for energy-producing and pollution-abatement operations 21 p0064 A79-14109
- Advanced processes for generation of electric power - Solvent refining of coal and combined cycle plants 21 p0064 A79-14110
- State-of-the-art assessment of air pollution control technologies for various waste-as-fuel processes 21 p0064 A79-14111
- Pollution perspective for geothermal energy development 21 p0064 A79-14114
- Long-term availability of water resources for energy development in the Central United States 21 p0065 A79-14118
- Summary of international energy research and development activities 1974-1976 --- Book 21 p0068 A79-14400
- Annual Conference on Energy, 4th, University of Missouri-Rolla, Rolla, Mo., October 11-13, 1977, Proceedings. Volume 4 21 p0071 A79-14676
- Recovery of oil from oil shale - An overall technological perspective 21 p0073 A79-14698
- Annual review of energy. Volume 3 --- Book 21 p0074 A79-14718
- Energy technologies and natural environments - The search for compatibility 21 p0074 A79-14721
- Seminar on Geothermal Energy, 1st, Brussels, Belgium, December 6-8, 1977, Proceedings. Volumes 1 & 2 21 p0075 A79-14726
- Miami International Conference on Alternative Energy Sources, Miami Beach, Fla., December 5-7, 1977, Proceedings of Condensed Papers 21 p0076 A79-14760
- Results of a tilt-tilt low profile heliostat test program 21 p0076 A79-14761
- Basic technical and economical aspects of the use of solar energy for pumping irrigation water 21 p0076 A79-14763
- Solar energy - Past and present developments 21 p0076 A79-14764
- Feature review of some advanced and innovative design concepts in wind energy conversion systems 21 p0077 A79-14771
- Salinity power station at the Swedish west-coast - Possibilities and energy-price for a 200 MW-plant 21 p0077 A79-14772
- Useful power from ocean waves 21 p0077 A79-14773
- A challenging role for the assurance sciences --- in energy conversion technology 21 p0086 A79-15396
- Conference on Performance Monitoring Techniques for Evaluation of Solar Heating and Cooling Systems, Washington, D.C., April 3, 4, 1978, Proceedings 21 p0087 A79-15826
- Energy technology V: Challenges to technology; Proceedings of the Fifth Conference, Washington, D.C., February 27-March 1, 1978 21 p0091 A79-15879
- Biomimetic approach to solar energy conversion - Artificial photosynthesis 21 p0094 A79-15899
- OTEC program status and plans 21 p0094 A79-15902
- Power generation using thermal vapor pumping and hydro-pumped storage - Thermal gradient utilization cycle /TGUC/ 21 p0095 A79-15914
- New concepts in waste utilization and biomass 21 p0095 A79-15915
- Energy from urban waste 21 p0096 A79-15917
- Advanced processes for more efficient use of forest products residual material 21 p0096 A79-15919
- Coal-based electricity and air pollution control - A case for solvent refined coal 21 p0096 A79-15922
- Westinghouse fluidized bed coal gasification system - Experience and plans 21 p0096 A79-15924
- Energy/environment technology areas to be developed 21 p0097 A79-16077
- A comparative analysis of three of ERDA's major R & D programs 21 p0099 A79-16121
- A methodological note on the evaluation of new technologies - The case of coal gasification 21 p0099 A79-16122
- Technology transfer at Department of Energy laboratories - Selected case studies from the Lawrence Livermore Laboratory 21 p0099 A79-16130
- Ocean thermal energy conversion; Proceedings of the Energy Technology Conference and Exhibition, Houston, Tex., November 6-9, 1978 21 p0100 A79-16245
- Some early and recent novel OTEC systems 21 p0100 A79-16246
- OTEC power systems 21 p0101 A79-16248
- International Symposium-Workshop on Solar Energy, Cairo, Egypt, June 16-22, 1978, Symposium Lectures 21 p0102 A79-16451
- The economics and policy of alternative energy sources - A review 21 p0103 A79-16454
- Solar-hydrogen energy system and solar-hydrogen production methods 21 p0104 A79-16463
- Prospects for ambient energy and cogeneration utilization in urban and regional planning 21 p0104 A79-16465
- Open-cycle magnetohydrodynamic electrical power generation --- Book 21 p0104 A79-16478
- MHD generators --- Faraday, Hall and diagonal generator designs 21 p0105 A79-16484
- Materials --- for high temperature MHD technology 21 p0106 A79-16491
- Radiation energy conversion in space; Conference, 3rd, NASA Ames Research Center, Moffett Field, Calif., January 26-28, 1978, Technical Papers 21 p0107 A79-16601
- A search for space energy alternatives 21 p0108 A79-16608

## SUBJECT INDEX

## ENERGY TECHNOLOGY CONTD

- Energy '78; Annual Conference, Tulsa, Okla., April 16-18, 1978, Record of Conference Papers 21 p0111 A79-16726
- The impact of advanced technology on the future electric energy supply problem 21 p0112 A79-16736
- Macro-energy model - Impact of public policy on technological development 21 p0113 A79-16741
- Energy systems: An analysis for engineers and policy makers --- Book 21 p0114 A79-17218
- Potential research problems in energy systems analysis 21 p0115 A79-17221
- Energy economics - A research analysis --- considering OPEC Cartel impact 21 p0115 A79-17222
- The solar energy R & D programme of the European Communities 21 p0116 A79-17278
- Solar energy in Latin America - An overview 21 p0116 A79-17279
- Report on the development of solar energy in France 21 p0117 A79-17280
- The accomplishments of the United States Federal Solar Energy Program 21 p0117 A79-17281
- Solar energy research, development and demonstration program in Kuwait 21 p0117 A79-17282
- Solar energy activities in Austria 21 p0117 A79-17283
- Solar energy R&D in Iran - The approach and the philosophy 21 p0117 A79-17284
- Solar energy in Southern Africa 21 p0117 A79-17287
- Solar electrification and rural electrification - A techno-economic review 21 p0118 A79-17289
- The relationship between diffuse and total solar radiation in computer simulation of solar energy systems 21 p0119 A79-17304
- Energy through solar aided bio-gas systems 21 p0125 A79-17367
- Bio-mass energy for rural areas 21 p0126 A79-17373
- Status report on selective surfaces --- solar collector absorbers 21 p0126 A79-17374
- Cost effective optimum design of solar air heaters 21 p0127 A79-17386
- Optimum collection geometries for copper tube - copper sheet flat plate collectors 21 p0127 A79-17387
- Solar energy use in Denmark /56 deg N/ and higher latitudes in Scandinavia 21 p0128 A79-17393
- Double-exposure collector system for solar heating applications 21 p0131 A79-17411
- Annual collection and storage of solar energy for the heating of buildings 21 p0131 A79-17415
- A report on the various heat collection and heat storage systems evolved under the solar energy programme at B. I. T. S. 21 p0132 A79-17423
- Liquid solar collector --- low cost assemblage with black water working fluid 21 p0133 A79-17433
- P.E.R.I.C.L.E.S. - Design of a stationary spherical collector --- solar energy application 21 p0134 A79-17441
- Performance of solar heating and cooling systems used in the national solar heating and cooling demonstration program 21 p0139 A79-17478
- Application of turbopack in solar energy systems 21 p0141 A79-17504
- Coal technology '78; International Coal Utilization Convention, Houston, Tex., October 17-19, 1978, Conference Papers. Volumes 1 & 2 21 p0145 A79-17631
- The Koppelman process --- to upgrade lignite and some waste energy sources 21 p0145 A79-17634
- The H-Coal project --- catalytic hydrogenation of coal 21 p0145 A79-17635
- Synthetic fuels from coal 21 p0145 A79-17636
- A summary of R&D programs --- for coal utilization 21 p0146 A79-17639
- Coal - Meeting the energy challenge 21 p0147 A79-17647
- Solar energy --- conversion technologies 21 p0147 A79-17648
- Solar power satellites - An AIAA position paper 21 p0148 A79-17872
- Two thermodynamic optima in the design of sensible heat units for energy storage 21 p0150 A79-18091
- Thermosyphon models for downhole heat exchanger applications in shallow geothermal systems 21 p0150 A79-18092
- The theoretical analysis of an air turbine generation system --- for waterwave energy conversion 21 p0151 A79-18106
- Energy related mathematical models - Annotated bibliography 21 p0154 A79-18472
- Recent developments in pressurized fluidized bed coal combustion research [AIAA PAPER 79-0190] 21 p0157 A79-19589
- Program to establish ceramic technology readiness for large combustion turbine utility application [ASME PAPER 78-WA/GT-8] 21 p0160 A79-19796
- Development of compact heat exchangers for Ocean Thermal Energy Conversion /OTEC/ systems [ASME PAPER 78-WA/HT-34] 21 p0161 A79-19815
- Accelerating the commercialization on new technologies --- free market operation of federal alternate energy sources programs [ASME PAPER 78-WA/TS-4] 21 p0164 A79-19849
- The sodium/sulfur battery - A storage battery for peak load adjustment and electric traction 21 p0165 A79-20244
- Tidal power in the Bay of Pundy 22 p0237 A79-20729
- Selective application of materials for products, and energy; Proceedings of the Twenty-third National Symposium and Exhibition, Anaheim, Calif., May 2-4, 1978 22 p0239 A79-20801
- An evolutionary solar power satellite program [AAS PAPER 78-153] 22 p0243 A79-21265
- Hydrides for energy storage; Proceedings of the International Symposium, Geilo, Norway, August 14-19, 1977 22 p0247 A79-21676
- The prospects of hydrogen as an energy carrier for the future 22 p0247 A79-21677
- International Conference on Thermoelectric Energy Conversion, 2nd, University of Texas, Arlington, Tex., March 22-24, 1978, Proceedings and Supplement 22 p0259 A79-23603
- Synthetic chloroplasts --- for photosynthetic solar energy conversion 22 p0262 A79-23721
- Modeling and simulation. Volume 9 - Proceedings of the Ninth Annual Pittsburgh Conference, University of Pittsburgh, Pittsburgh, Pa., April 27, 28, 1978. Part 1 - Energy and power system modeling - Ecological and biomedical modeling. Part 2 - Socioeconomic modeling. Part 3 - Control and identification. Part 4 Methodology and applications 22 p0263 A79-23776
- Oil shale in the U.S. - Current state of technology and research 22 p0265 A79-23830
- Industrial cogeneration - Problems and promise --- waste heat utilization from electricity production 22 p0265 A79-24047
- Risk with energy from conventional and nonconventional sources 22 p0266 A79-24151
- Tropospheric conduits --- for pollution abatement and energy production 22 p0266 A79-24275

- Modeling, simulation, testing, and measurements for solar energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978 22 p0266 A79-24309
- Stormy development of wind energy technology utilization --- German 22 p0268 A79-24323
- The solar power satellite concept - The past decade and the next decade [AIAA PAPER 79-0534] 22 p0273 A79-25854
- Fluids engineering in advanced energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978 22 p0278 A79-26176
- Radiation regime of inclined surfaces --- Russian book on solar energy engineering and microclimatology 22 p0282 A79-26353
- Energy development --- for future global demand 22 p0282 A79-26402
- Contribution to the development of wind energy systems using static power electronic converters 22 p0286 A79-26958
- No ill winds for New Mexico utility --- windpower utilization in municipal electric power system 22 p0286 A79-27208
- Principles of solar engineering --- Book 22 p0287 A79-27372
- Applications of cryogenic technology. Volume 7 - Proceedings of the Conference on Cryogenic Energy Systems, Oak Brook, Ill., May 16-18, 1978 22 p0289 A79-27651
- Hydrogen via gasification - Today and tomorrow 22 p0289 A79-27652
- Progress in solid polymer electrolyte water electrolysis --- for large-scale hydrogen production 22 p0289 A79-27653
- Hydrogen via thermochemistry and future water-splitting technologies 22 p0289 A79-27654
- An overview of the STOR hydrogen energy program 22 p0289 A79-27655
- An overview of liquid metal MHD --- for power generation 22 p0289 A79-27660
- Status of the U.S./U.S.S.R. cooperative program for the development of open-cycle MHD power generators 22 p0290 A79-27661
- Superconducting magnet systems for MHD generator facilities 22 p0290 A79-27662
- Doublet III --- tokamak program review 22 p0290 A79-27667
- Status report on TFTR --- Toroidal Fusion Test Reactor 22 p0290 A79-27669
- Optics applied to solar energy IV; Proceedings of the Seminar, San Diego, Calif., August 30, 31, 1978 22 p0293 A79-28140
- Energy conversion engineering --- Book 22 p0302 A79-29575
- Heat pump technology for saving energy --- Book 22 p0302 A79-29624
- Some recent developments in wind and ocean power systems 22 p0303 A79-29797
- The impact of alternate energy resources on the future supply of electric power [IEEE PAPER 78 672-8] 22 p0304 A79-29939
- The potential for solar energy development 22 p0304 A79-30172
- Energy, resources, and policy --- Book 22 p0304 A79-30175
- Refrigeration requirements for future superconductive energy related applications 22 p0311 A79-31019
- Renewable alternatives; Proceedings of the Fourth Annual Conference, University of Western Ontario, London, Canada, August 20-24, 1978. Volumes 1 & 2 22 p0316 A79-31401
- Energy and aerospace; Proceedings of the Anglo/American Conference, London, England, December 5-7, 1978 22 p0325 A79-31908
- Energy research and development - A U.K. view 22 p0325 A79-31910
- Design and application of large wind turbine generators 22 p0326 A79-31911
- Solar Power Satellite systems definition 22 p0326 A79-31920
- Photovoltaics and solar thermal conversion to electricity - Status and prospects 22 p0326 A79-31924
- Methane generation from human, animal, and agricultural wastes [PB-276469/4] 21 p0171 A79-10240
- Thermal energy storage subsystems [NASA-CR-150812] 21 p0172 A79-10517
- Solar system installation at Louisville, Kentucky [NASA-CR-150814] 21 p0172 A79-10518
- Development of surfaces optically suitable for flat solar panels [NASA-CR-150831] 21 p0173 A79-10522
- Direct heat applications of geothermal energy in the geysers/Clear Lake Region, volume 2: Environmental assessment [SAN/1326-1/2] 21 p0174 A79-10532
- Feasibility study of transporting offshore OTEC-produced energy to shore by thermal media. Project 8980 [DSE/2426-19] 21 p0174 A79-10535
- System for projecting the utilization of renewable resources. SPURR methodology [ERHQ/2322-77/4] 21 p0174 A79-10538
- Solar powered irrigation: Present status and future outlook [SAND-78-0016C] 21 p0175 A79-10539
- Environmental development Plan (EDP). Oil supply, FY 1977 [DOE/EDP-0024] 21 p0175 A79-10545
- Solar energy concentrator design and operation. Citations from the NTIS data base [NTIS/PS-78/0838/9] 21 p0178 A79-10566
- Technology assessment, volume 2. A bibliography with abstracts [NTIS/PS-78/0830/6] 21 p0179 A79-10951
- Surfactant-assisted liquefaction of particulate carbonaceous substances [NASA-CASE-NPO-13904-1] 21 p0179 A79-11152
- Preliminary design and analysis of a total energy system for Massachusetts Institute of Technology [AD-A057289] 21 p0184 A79-11486
- Electric batteries. A bibliography [TID-3361] 21 p0184 A79-11491
- Design guide for shallow solar ponds [UCRL-52385] 21 p0185 A79-11497
- Economics of Texaco gasification: Combined cycle systems. Economic studies of coal gasification combined cycle systems for electric power generation [EPRI-AP-753] 21 p0185 A79-11498
- Annual highlights of the energy technology programs [BHL-50799] 21 p0185 A79-11499
- Biomimetic approach to solar energy conversion: Artificial photosynthesis [CONF-780222-5] 21 p0186 A79-11506
- Fundamental data needs for coal conversion technology appendices [TID-28152-APP] 21 p0187 A79-11512
- Solar irrigation program plan: Second revision [SAND-78-0308-REV] 21 p0187 A79-11525
- Integrating technologies to produce energy conservation [CONF-780109-6] 21 p0189 A79-11541
- International project catalog of modular integrated utility systems [PB-283477/8] 21 p0190 A79-11544
- Committee on the Challenges of Modern Society Rational use of Energy Pilot Study Modular Integrated Utility Systems Project. Volume 1: Description, activities, and products [PB-283428/1] 21 p0190 A79-11549
- Energy-related pollutants in the environment: The use of short-term for mutagenicity in the isolation and identification of biohazards [CONF-780121-2] 21 p0192 A79-11568
- Overview of the magnetic fusion energy development and technology program [HCP/T3073-01] 21 p0193 A79-11887
- Assessment of SEPS solar array technology for orbital service module application [NASA-CR-151859] 21 p0194 A79-12136

## SUBJECT INDEX

## ENERGY TECHNOLOGY CONTD

- Alternative energy sources for Federal Aviation Administration facilities  
[AD-A058681] 21 p0196 N79-12555
- Satellite Power System (SPS) environmental impacts, preliminary assessment  
[NASA-CR-157952] 21 p0196 N79-12557
- Satellite Power System (SPS) microwave subsystem impacts and benefits  
[NASA-CR-157951] 21 p0196 N79-12558
- Energy information data base: Serial titles  
[TID-4579-R10] 21 p0197 N79-12566
- Environmental Development Plan (EDP): Photovoltaics, 1977  
[DOE/EDP-0003] 21 p0198 N79-12569
- Combined photovoltaic thermal collector testing  
[SAND-78-1191C] 21 p0198 N79-12570
- Managing oil and gas activities in coastal environments  
[PB-283677/3] 21 p0199 N79-12576
- Technical and environmental aspects of oil shale processing  
21 p0199 N79-12581
- Status of alcohol fuels utilization technology for highway transportation  
[HCP/H2923-01] 21 p0201 N79-13190
- LARGO hot water system thermal performance test report  
[NASA-CR-150841] 21 p0205 N79-13500
- Improved anodes for liquid hydrocarbon fuel cell  
[AD-A058456] 21 p0206 N79-13504
- Program information notice --- technologies relevant to u.s. electric energy systems  
[DOE/ET-0059] 21 p0207 N79-13517
- Analytical framework for the assessment of energy resource and technology options for developing countries  
[BNL-50800] 21 p0208 N79-13524
- Photovoltaic program: Program summary  
[DOE/ET-0019/1] 21 p0209 N79-13529
- Solar evacuated tube collector: Absorption chiller systems simulation  
[COO-2577-13] 21 p0209 N79-13530
- Heat pump technology: A survey of technical developments, market prospects and research needs  
[HCP/H2121-01] 21 p0210 N79-13540
- Noise-control needs in the developing energy technologies  
[COO-4389-1] 21 p0213 N79-13569
- Energy and Technology Review, June 1978 --- composite materials for flywheels, shale oil recovery, and seismic safety at nuclear power plants  
[UCRL-52000-78-6] 21 p0215 N79-14168
- Naval Air Systems Command-Naval Research Laboratory Workshop on Basic Research Needs for Synthetic Hydrocarbon Jet Aircraft Fuels  
[AD-A060081] 21 p0216 N79-14235
- High energy HHD fuels development program  
[AD-A060156] 21 p0216 N79-14239
- Technology and Use of Lignite --- conferences  
[GPERC/IC-77/1] 21 p0216 N79-14241
- Back wall solar cell  
[NASA-CASE-LEW-12236-2] 21 p0217 N79-14528
- Application of solar technology to today's energy needs, volume 2 --- systems analysis and analytical methods  
[OTA-E-77-VOL-2] 21 p0218 N79-14530
- Conceptual approach study 200 watt per kilogram solar array, phase 3  
[NASA-CR-158046] 21 p0219 N79-14551
- Design and installation package for solar hot water system  
[NASA-CR-150859] 21 p0220 N79-14556
- Preliminary design package for prototype solar heating system  
[NASA-CR-150858] 21 p0220 N79-14557
- Water related constraints in energy production  
[PB-285713/4] 21 p0222 N79-14582
- Combined cycle power generation. Citations from the NTIS data base  
[NTIS/PS-78/1156/5] 21 p0222 N79-14587
- Combined cycle power generation. Citations from the Engineering Index data base  
[NTIS/PS-78/1157/3] 21 p0222 N79-14588
- Statement of Ivan Bekey, Director of Advanced Mission Studies, Aerospace Corporation  
21 p0224 N79-15107
- Statement of Doctor Krafft A. Ehrlicke, President, Space Global, La Jolla, California  
21 p0224 N79-15108
- Design data brochure for the Owens-Illinois Sunpak (TM) air-cooled solar collector  
[NASA-CR-150868] 21 p0229 N79-15404
- Proceedings of Energy Resource 5th Conference  
[PB-286246/4] 21 p0230 N79-15423
- Fundamental combustion studies of emulsified fuels for diesel applications  
[PB-287386/7] 22 p0330 N79-16138
- An operating 200-kW horizontal axis wind turbine  
[NASA-TN-79034] 22 p0333 N79-16357
- Local perceptions of energy development: The case of the Kaiparowits Plateau  
[PB-287314/9] 22 p0335 N79-16380
- The effects of resource impact factors on energy conservation standards for buildings  
[PB-286909/7] 22 p0335 N79-16384
- The AGARD propulsion and energetics panel; 1952-1977  
[AGARD-AR-111] 22 p0337 N79-16848
- Energy environment III  
[EPA-600/9-78-022] 22 p0346 N79-18352
- Status of bioscreening of emissions and effluents from energy technologies  
22 p0346 N79-18353
- Ecological effects of coal-fired steam-electric generating stations  
22 p0346 N79-18358
- Methods for the control of environmental damage caused by mining energy producing materials  
22 p0347 N79-18359
- Technology assessment of western energy resource development  
22 p0347 N79-18368
- Austrian 10kWE solar power plant. A project of the Federal Ministry for Science and Research  
22 p0349 N79-18460
- Public hearing transcript: Federal non-nuclear energy research and development program  
[PB-287910/4] 22 p0349 N79-18464
- Energy analyses applied to ocean thermal energy conversion and an offshore wind power system  
22 p0353 N79-19442
- Solar cell module assembly jig  
[NASA-CASE-XGS-00829-1] 22 p0353 N79-19447
- Development of an improved high efficiency thin silicon solar cell  
[NASA-CR-158172] 22 p0354 N79-19459
- Energy/environment 1978: Symposium on energy development impacts  
[PB-288578/8] 22 p0355 N79-19470
- Cost analysis and optimization study for solar heating and cooling systems, Stillwater, Minnesota and Newcastle, Pennsylvania  
[NASA-CR-161201] 22 p0358 N79-20478
- Automated array assembly, phase 2  
[NASA-CR-158360] 22 p0358 N79-20480
- Automated array assembly, phase 2. Low-cost solar array project, task 4  
[NASA-CR-158365] 22 p0358 N79-20481
- Phase two of the array automated assembly task for the low cost solar array project  
[NASA-CR-158359] 22 p0359 N79-20484
- Silicon solar cell process development, fabrication and analysis  
[NASA-CR-158363] 22 p0359 N79-20485
- Utility operational experience on the NASA/DOE MOD-0A 200-kW wind turbine  
[NASA-TN-79084] 22 p0360 N79-20494
- Cost analysis and optimization study for solar heating and cooling systems  
[NASA-CR-161200] 22 p0360 N79-20499
- MDH balance of plant technology project  
[ANL-MHD-78-7] 22 p0361 N79-20500
- Material growth and characterization directed toward improving III-V heterojunction solar cells  
[NASA-CR-158476] 22 p0367 N79-21543
- Active heat exchange system development for latent heat thermal energy storage  
[NASA-CR-159479] 22 p0368 N79-21554
- Liquid-fluidized-bed heat exchanger flow distribution models  
[ICP-1151] 22 p0369 N79-21559
- The Brookhaven buildings energy conservation optimization model  
[BNL-50828] 22 p0370 N79-21564

## ENERGY TRANSFER

## SUBJECT INDEX

- Development, testing, and certification of Owens-Illinois model SEC-601 solar energy collector system [NASA-TM-78223] 22 p0371 A79-21620
- Long term weathering effects on the thermal performance of the solaron (air) solar collector [NASA-CR-161166] 22 p0371 A79-21621
- An inventory of environmental impact models related to energy technologies [ORNL/EIS-147] 22 p0372 A79-21640
- ENERGY TRANSFER**
- The efficiencies of thermochemical energy transfer 21 p0054 A79-13575
- Solar thermal conversion 21 p0104 A79-16466
- Energy exchanger technology applied to laser heated engines 21 p0110 A79-16631
- Alternative forms of energy transmission from OTEC plants 21 p0141 A79-17505
- The role of interfacial heat and mechanical energy transfers in a liquid-metal MHD generator [ASME PAPER 78-WA/HT-33] 21 p0161 A79-19814
- Screening reversible reactions for thermochemical energy transfer 22 p0285 A79-26823
- The effect of thermo-electric forces on the density profiles in a thermonuclear plasma surrounded by a cold blanket 22 p0292 A79-27886
- Laser power conversion system analysis, volume 1 [NASA-CR-159523-VOL-1] 22 p0366 A79-21334
- Laser power conversion system analysis, volume 2 [NASA-CR-159523-VOL-2] 22 p0366 A79-21335
- ENGINE CONTROL**
- Powerplant integration - The application of current experience to future developments [ASME PAPER 78-GT-113] 21 p0032 A79-10788
- A multivariable controller for an automotive gas turbine [ASME PAPER 79-GT-73] 22 p0307 A79-30537
- ENGINE DESIGN**
- A review of the PFBC combined cycle and its influence on gas turbine design parameters --- Pressurized Fluidized Bed Combustion 21 p0007 A79-10067
- Some problems and benefits from the hydrogen fueled spark ignition engine 21 p0016 A79-10130
- Combined cycle gas turbine for an automobile application 21 p0019 A79-10157
- Balanced compounding of Stirling machines 21 p0024 A79-10200
- Conversion of a standard single cylinder I.C. engine into a 'gamma' configuration air charged Stirling engine 21 p0024 A79-10202
- Design of a preprototype Stirling Laboratory Research Engine 21 p0024 A79-10203
- The matching of a free piston Stirling engine coupled with a free piston linear compressor for a heat pump application 21 p0024 A79-10204
- Conceptual design of a variable displacement Stirling engine for automotive propulsion 21 p0025 A79-10207
- Mechanical efficiency of the Stirling cycle machine with rhombic drive 21 p0025 A79-10208
- Development of a 1 kW/e/ isotope fueled Stirling cycle power system 21 p0025 A79-10210
- Potential of the Stirling engine for stationary power applications in the 500-2000 HP range 21 p0025 A79-10211
- Status of free-piston Stirling engine/linear alternator power conversion system development 21 p0025 A79-10212
- Nitinol heat engines for economical conversion of low grade thermal density 21 p0027 A79-10230
- Research on the sodium heat engine 21 p0028 A79-10231
- Quasi-equilibrium Air Standard heat balanced cycle analysis 21 p0028 A79-10232
- Development of gas turbine performance seeking logic [ASME PAPER 78-GT-13] 21 p0031 A79-10257
- Evaluation program for new industrial gas turbine materials [ASME PAPER 78-GT-145] 21 p0031 A79-10269
- Powerplant integration - The application of current experience to future developments [ASME PAPER 78-GT-113] 21 p0032 A79-10788
- Development of a compact gas turbine combustor to give extended life and acceptable exhaust emissions [ASME PAPER 78-GT-146] 21 p0033 A79-10799
- Advanced turbofan engines for low fuel consumption [ASME PAPER 78-GT-192] 21 p0033 A79-10816
- Making turbofan engines more energy efficient [ASME PAPER 78-GT-198] 21 p0033 A79-10818
- Current problems in the development and production of small gas turbine engines 21 p0048 A79-12529
- Reliability and durability of ceramic regenerators for gas turbine applications 21 p0050 A79-12823
- Designing and testing Si3N4 turbine components at Mercedes-Benz 21 p0050 A79-12830
- Development of ceramic parts for a truck gas turbine at MTU 21 p0050 A79-12831
- Preliminary design of a subscale ceramic helical-rotor expander 21 p0050 A79-12849
- Ceramics for the advanced automotive gas turbine engine - A look at a single shaft design 21 p0050 A79-12850
- Energy exchanger technology applied to laser heated engines 21 p0110 A79-16631
- Quasi-isentropic laser engines 21 p0111 A79-16632
- Technology evolution in the Allison Model 250 engine --- for helicopter propulsion 21 p0155 A79-18681
- The Stirling engine, an energy converter for cogeneration applications [ASME PAPER 78-WA/ENER-4] 21 p0159 A79-19777
- Design and development of a monorotor gas turbine auxiliary power unit [ASME PAPER 78-WA/GT-2] 21 p0160 A79-19791
- Fuel conservative aircraft engine technology 21 p0164 A79-20078
- Ceramic materials for vehicular gas turbine applications 21 p0165 A79-20085
- Recent advances in convectively cooled engine and airframe structures for hypersonic flight 21 p0165 A79-20087
- Digital or analog modelling in the design of hydrostatic vehicular systems 22 p0264 A79-23808
- Optimization of a novel hydrostatic drive performance using hybrid computing technique --- for automobile engines 22 p0264 A79-23809
- Engine technology for production turbofan engines 22 p0270 A79-24827
- Wind power distribution, control, and conversion in vortex augmentors --- influence on turbomachinery design and development 22 p0278 A79-26180
- Some flow analyses for Tornado-type wind turbines 22 p0279 A79-26181
- Diffuser designs for improved wind energy conversion 22 p0279 A79-26182
- High efficiency wave engine --- featuring rotor blade exit nozzle design for high efficiency 22 p0279 A79-26187
- Working fluids and turbines for OTEC power systems 22 p0280 A79-26192
- Operational characteristics of MHD turbine with air-core superconducting rotor 22 p0297 A79-28924
- Solar Rankine engines - Examples and projected costs [ASME PAPER 79-SOL-3] 22 p0307 A79-30541
- Foil type bearings for the Chrysler Automotive Gas Turbine Engine Program - Development and operational experiences [SAE PAPER 790109] 22 p0314 A79-31356



# SUBJECT INDEX

# ENVIRONMENT EFFECTS

- Some design considerations of automotive gas turbines  
[SAE PAPER 790128] 22 p0314 A79-31360
- Field experience with the Detroit Diesel Allison 404/505 industrial gas turbine engines  
[SAE PAPER 790129] 22 p0314 A79-31361
- Emissions and economy potential of prechamber stratified charge engines  
[SAE PAPER 790436] 22 p0315 A79-31374
- A new combustion system in the three-valve stratified charge engine  
[SAE PAPER 790439] 22 p0316 A79-31376
- A hybrid wind turbine suitable for developing regions  
22 p0323 A79-31455
- The NASA Aircraft Energy Efficiency program  
22 p0325 A79-31912
- Energy efficient engine preliminary design and integration study  
[NASA-CR-135396] 21 p0194 N79-12084
- Analytical evaluation of the impact of broad specification fuels on high bypass turbofan engine combustors  
[NASA-CR-159454] 21 p0200 N79-13050
- Aircraft Engine Future Fuels and Energy Conservation  
[AGARD-15-96] 21 p0201 N79-13192
- Low energy consumption engines  
21 p0202 N79-13199
- Fluidized bed gas turbine experimental unit for MUIS applications  
[ORNL/HUD/MUIS-32] 21 p0220 N79-14564
- The rotary combustion engine: A candidate for general aviation --- conferences  
[NASA-CP-2067] 22 p0329 N79-15961
- Development status of rotary engine at Toyo Kogyo --- for general aviation aircraft  
22 p0329 N79-15964
- Update of development on the new Audi NSU rotary engine generation --- for application to aircraft engines  
22 p0329 N79-15965
- Review of the Rhein-Flugzeugbau Wankel powered aircraft program --- ducted fan engines  
22 p0329 N79-15966
- Rotary engine developments at Curtiss-Wright over the past 20 years, and review of general aviation engine potential --- with direct chamber injection  
22 p0329 N79-15967
- Engine requirements for future general aviation aircraft  
22 p0329 N79-15968
- New initiatives in high altitude aircraft  
22 p0338 N79-17000
- ENGINE PARTS**
- Reliability and durability of ceramic regenerators for gas turbine applications  
21 p0050 A79-12823
- Development of ceramic parts for a truck gas turbine at MTU  
21 p0050 A79-12831
- Ceramic applications in the advanced Stirling automotive engine  
21 p0051 A79-12851
- Ceramic materials for vehicular gas turbine applications  
21 p0165 A79-20085
- ENGINE STARTERS**
- Testing to assess the affect of degraded fuel specifications on the cold start ability of a T63-A-700 engine  
[AIAA 79-7009] 22 p0300 A79-29384
- ENGINE TESTS**
- Status of free-piston Stirling engine/linear alternator power conversion system development  
21 p0025 A79-10212
- Investigating combustion turbine burner performance with coal derived liquids having high fuel bound nitrogen  
[ASME PAPER 78-GT-126] 21 p0033 A79-10791
- Modern engine development test techniques --- for helicopters  
21 p0155 A79-18680
- Testing to assess the affect of degraded fuel specifications on the cold start ability of a T63-A-700 engine  
[AIAA 79-7009] 22 p0300 A79-29384
- Soot and the combined cycle boiler  
[ASME PAPER 79-GT-67] 22 p0307 A79-30533
- Poil type bearings for the Chrysler Automotive Gas Turbine Engine Program - Development and operational experiences  
[SAE PAPER 790109] 22 p0314 A79-31356
- Field experience with the Detroit Diesel Allison 404/505 industrial gas turbine engines  
[SAE PAPER 790129] 22 p0314 A79-31361
- Initial comparison of single cylinder Stirling engine computer model predictions with test results  
[SAE PAPER 790327] 22 p0315 A79-31368
- The Stirling engine for automotive application  
[SAE PAPER 790329] 22 p0315 A79-31370
- The influence of overall equivalence ratio and degree of stratification on the fuel consumption and emissions of a prechamber, stratified-charge engine  
[SAE PAPER 790438] 22 p0315 A79-31375
- Variable-displacement spark-ignition engine  
[SAHD-77-8299] 21 p0172 N79-10435
- Performance characteristics of automotive engines in the United States. Second series: Report no. 5 1977 Ford 140 CID (2.3 liters), 2V --- fuel consumption and exhaust gases  
[PB-286076/5] 21 p0227 N79-15306
- Performance characteristics of automotive engines in the United States Third series: Report No. 1 1977 Volvo 130 CID (2.1 liters), P.I. --- fuel consumption and exhaust gases  
[PB-286077/3] 21 p0227 N79-15307
- Performance characteristics of automotive engines in the United States. First series, report no. 18: 1976 Ford CID (6.6 liters), 2V --- fuel consumption and exhaust gases  
[PB-286299/3] 21 p0227 N79-15313
- Initial comparison of single cylinder Stirling engine computer model predictions with test results  
[NASA-TN-79044] 22 p0337 N79-16721
- Tests of Wisconsin S12D engine running on natural gas with addition of carbon dioxide  
[AD-A058486] 22 p0339 N79-17230
- Single-cylinder diesel engine tests with unstabilized water-in-fuel emulsions  
[AD-A062751] 22 p0366 N79-21406
- ENGINEERING MANAGEMENT**
- Geothermal Reservoir Engineering Management Program Plan (GREMP Plan)  
[LBL-7000] 21 p0174 N79-10536
- ENTROPY**
- Solar energy and the second law of thermodynamics  
21 p0118 A79-17292
- ENVIRONMENT EFFECTS**
- Environmental considerations for the microwave beam from a solar power satellite  
21 p0003 A79-10030
- Energy and the environment; Proceedings of the Fifth National Conference, Cincinnati, Ohio, November 1-3, 1977  
21 p0063 A79-14106
- Energy technologies and natural environments - The search for compatibility  
21 p0074 A79-14721
- Environmental impacts of industrial energy systems in the coastal zone  
21 p0075 A79-14722
- Environmental effects of burning solid waste as fuel  
21 p0082 A79-15115
- A commentary on a methodology for assessment of the environmental impact of the electrical power system within the Connecticut River Basin  
21 p0093 A79-15893
- Net energy analysis and environmental aspects for solar tower central receiver systems. I - Methodology  
21 p0097 A79-16101
- A multivariate-utility approach for selection of energy sources  
21 p0098 A79-16120
- The NED power plant and its environmental aspects - Introduction  
21 p0105 A79-16479
- SPS microwave subsystem potential impacts and benefits --- environmental and societal effects of Solar Power System construction and operation  
21 p0107 A79-16603
- Solar power satellites - An AIAA position paper  
21 p0148 A79-17872

# ENVIRONMENT MANAGEMENT

# SUBJECT INDEX

Mercury in some New Zealand geothermal discharges  
22 p0257 A79-22925

Factors affecting bitumen recovery by the hot  
water process  
22 p0282 A79-26463

Climatic change in connection with energy growth  
--- resource consumption effects  
22 p0284 A79-26623

Environmental considerations for siting an ocean  
thermal conversion early ocean testing platform  
at four proposed areas  
22 p0287 A79-27377

Energy conversion engineering --- Book  
22 p0302 A79-29575

Preliminary assessment of the environmental  
impacts of the Satellite Power System /SPS/  
22 p0326 A79-31922

Direct heat applications of geothermal energy in  
the geysers/Clear Lake Region, volume 2:  
Environmental assessment  
[SAN/1326-1/2] 21 p0174 A79-10532

National coal utilization assessment: An  
integrated assessment of increased coal use in  
the midwest: Impacts and constraints, volume 1  
[ANL/AA-11-VOL-1-DRAFT] 21 p0174 A79-10537

Preliminary environmental assessment of energy  
conversion processes for agricultural and forest  
product residues, volume 1  
[PB-281189/1] 21 p0178 A79-10574

Pollution control guidance for geothermal energy  
development  
[PB-282546/1] 21 p0178 A79-10604

Environmental assessment of solid residues from  
fluidized-bed fuel processing  
[PB-282940/6] 21 p0179 A79-10968

Environmentally induced cracking of natural gas  
and liquid pipelines. Volume 2: Appendices A  
and B  
[PB-282924/0] 21 p0181 A79-11446

Environmentally induced cracking of natural gas  
and liquid pipelines. Volume 1: Technical report  
[PB-282923/2] 21 p0181 A79-11447

Environmental Development Plan (EDP): Solar  
thermal power systems, 1977  
[DOE/EDP-0004] 21 p0187 A79-11522

Energy situation in the Mid-Atlantic region  
[BNL-50703] 21 p0188 A79-11528

Environmental Development Plan (EDP): Ocean  
thermal energy conversion, 1977  
[DOE/EDP-006] 21 p0188 A79-11531

Environmental Development Plan (EDP): Underground  
coal conversion program, FY 1977  
[DOE/EDP-0011] 21 p0192 A79-11569

A literature review-problem definition studies on  
selected toxic chemicals. Volume 8:  
Environmental aspects of diesel fuel and fog  
oils SGP number 1 and SGP number 2 and smoke  
screens generated from them  
[AD-A056021] 21 p0193 A79-11688

Satellite Power System (SPS) environmental  
impacts, preliminary assessment  
[NASA-CR-157952] 21 p0196 A79-12557

Environmental Development Plan (EDP):  
Photovoltaics, 1977  
[DOE/EDP-0003] 21 p0198 A79-12569

Energy supply and environmental impacts:  
Conventional sources, study module 3-A,  
technical appendix  
[PB-283787/0] 21 p0198 A79-12573

A Kentucky energy resource utilization program  
[PB-283796/1] 21 p0198 A79-12574

Energy and environment: An intergovernmental  
perspective  
[PB-283733/4] 21 p0198 A79-12575

Technical and environmental aspects of oil shale  
processing  
21 p0199 A79-12581

Energy systems studies program  
[BNL-50822] 21 p0209 A79-13526

Noise-control needs in the developing energy  
technologies  
[COO-4389-1] 21 p0213 A79-13569

Environmental effects of increased coal  
utilization ecological effects of gaseous  
emission from coal combustion  
[PB-285440/4] 21 p0213 A79-13591

An assessment of mercury emissions from fossil  
fueled power plants  
[PB-285227/5] 21 p0213 A79-13592

Source assessment: Water pollutants from coal  
storage areas  
[PB-285420/6] 21 p0223 A79-14635

Energy requirements of present pollution control  
technology  
[PB-286231/6] 21 p0223 A79-14643

Environmental assessment data base for coal  
liquefaction technology. Volume 1: Systems for  
14 liquefaction processes  
[PB-287799/1] 22 p0344 A79-17364

Environmental assessment data base for coal  
liquefaction technology. Volume 2: Synthoil,  
B-coal, and Exxon donor solvent processes  
[PB-287800/7] 22 p0344 A79-17365

Environmental assessment of the Alaskan  
Continental Shelf. Volume 1: Biological studies  
[PB-289154/7] 22 p0344 A79-17366

Environmental assessment of the Alaskan  
Continental Shelf. Volume 2: Biological studies  
[PB-289155/4] 22 p0344 A79-17367

Environmental assessment of the Alaskan  
Continental Shelf. Volume 3: Biological studies  
[PB-289156/2] 22 p0344 A79-17368

Changes in the terrestrial  
atmosphere-ionosphere-magnetosphere system due  
to ion propulsion for solar power satellite  
placement  
[NASA-TM-79719] 22 p0345 A79-17897

Energy environment III  
[EPA-600/9-78-022] 22 p0346 A79-18352

Ecological effects of coal-fired steam-electric  
generating stations  
22 p0346 A79-18358

Methods for the control of environmental damage  
caused by mining energy producing materials  
22 p0347 A79-18359

Impact prediction manual for geothermal development  
[PB-288128/2] 22 p0349 A79-18462

Environmental assessment data base for high-Btu  
gasification technology. Volume 1: Technical  
discussion  
[PB-288602/6] 22 p0350 A79-18487

Environmental assessment data base for high-Btu  
gasification technology. Volume 2: Appendices  
A, B, and C  
[PB-288603/4] 22 p0350 A79-18488

Environmental assessment data base for high-Btu  
gasification technology. Volume 3: Appendices  
D, E, and F  
[PB-288604/2] 22 p0350 A79-18489

Water-related environmental effects in fuel  
conversion, volume 1. Summary  
[PB-288313/0] 22 p0351 A79-18834

Energy/environment 1978: Symposium on energy  
development impacts  
[PB-288578/8] 22 p0355 A79-19470

Water-related environmental effects in fuel  
conversion. Volume 2: Appendices  
[PB-288874/1] 22 p0356 A79-19496

Environmental impact determination of action to be  
taken under the Energy Supply and Environmental  
Coordination Act for powerplants 1, 2, 3, and 4,  
Portsmouth Generating Station, Portsmouth,  
Virginia.  
[DOE/EA-0033] 22 p0362 A79-20514

Preliminary environmental assessment of biomass  
conversion to synthetic fuels  
[PB-289775/9] 22 p0365 A79-21224

An inventory of environmental impact models  
related to energy technologies  
[ORNL/EIS-147] 22 p0372 A79-21640

**ENVIRONMENT MANAGEMENT**

Environmental development Plan (EDP). Oil supply,  
FY 1977  
[DOE/EDP-0024] 21 p0175 A79-10545

**ENVIRONMENT MODELS**

Coupled heat and organic wastes stream pollution  
21 p0086 A79-15602

Drop formation, evaporation modelling and  
environmental assessment of JP-4 fuel jettisoned  
from aircraft  
[AIAA PAPER 79-0186] 21 p0157 A79-19585

An inventory of environmental impact models  
related to energy technologies  
[ORNL/EIS-147] 22 p0372 A79-21640

**ENVIRONMENT POLLUTION**

Pollution perspective for geothermal energy  
development  
21 p0064 A79-14114

# SUBJECT INDEX

# ENVIRONMENTAL SURVEYS

- Energy technologies and natural environments - The search for compatibility 21 p0074 A79-14721
- Fuel technology and the environment --- nuclear reactor caused radiation effects and transmutation 21 p0079 A79-14787
- Joint Conference on Sensing of Environmental Pollutants, 4th, New Orleans, La., November 6-11, 1977, Proceedings 21 p0082 A79-15023
- Drop formation, evaporation modelling and environmental assessment of JP-4 fuel jettisoned from aircraft [AIAA PAPER 79-0186] 21 p0157 A79-19585
- Some environmental and safety aspects of using hydrogen as a fuel 22 p0238 A79-20774
- Emissions from pressurized fluidized-bed combustion processes 22 p0261 A79-23640
- The natural and perturbed troposphere 21 p0179 A79-10636
- Energy-related pollutants in the environment: The use of short-term for mutagenicity in the isolation and identification of biohazards [CONF-780121-2] 21 p0192 A79-11568
- Catalyst evaluation for denitrogenation of petroleum residua and coal liquids, phase 5 [PB-287180/4] 22 p0339 A79-17026
- Ecological effects of coal-fired steam-electric generating stations 22 p0346 A79-18358
- Methods for the control of environmental damage caused by mining energy producing materials 22 p0347 A79-18359
- Environmental impact determination of action to be taken under the Energy Supply and Environmental Coordination Act for powerplants 1, 2, 3, and 4, Portsmouth Generating Station, Portsmouth, Virginia [DOE/EA-0033] 22 p0362 A79-20514
- A biologist's manual for the evaluation of impacts of coal-fired power plants on fish, wildlife and their habitats [PB-291330/9] 22 p0373 A79-21679
- ENVIRONMENTAL PROTECTION**
- Risk control in the development of energy processes --- environment, worker and capital considerations in coal gasification 21 p0085 A79-15372
- Energy/environment technology areas to be developed 21 p0097 A79-16077
- Clean Air Act amendments of 1977 and the impact on control efforts 21 p0097 A79-16091
- Protection of the biosphere --- MHD power stations pollution reduction 21 p0105 A79-16483
- Energy systems: An analysis for engineers and policy makers --- Book 21 p0114 A79-17218
- Perspectives on energy: Issues, ideas, and environmental dilemmas /2nd edition/ --- Book 21 p0147 A79-17646
- Toward a materials-conservation ethic 21 p0167 A79-20438
- Cogeneration in Europe and the combined cycle gas turbine 22 p0297 A79-28988
- Environmental control technology activities of the Department of Energy in FY 1977 [DOE/EV-0030] 21 p0178 A79-10572
- Technology assessment, volume 2. A bibliography with abstracts [NTIS/PS-78/0830/6] 21 p0179 A79-10951
- EPA program status report: Oil shale [PB-284480/1] 21 p0211 A79-13548
- Environmental and radiological safety studies. Interaction of (Pu-238)O<sub>2</sub> heat sources with terrestrial and aquatic environments --- soil and water analysis [LA-7033-PB] 21 p0232 A79-15783
- Environmental conservation concerns in transportation: Energy, noise, and air quality [PB-286550/9] 21 p0232 A79-15868
- Environmental effects of offshore oil production 22 p0336 A79-16389
- Research and development needs to merge environmental and energy objectives [GPO-23-254] 22 p0342 A79-17339
- Energy environment III [EPA-600/9-78-022] 22 p0346 A79-18352
- Status of bioscreening of emissions and effluents from energy technologies 22 p0346 A79-18353
- The development of a laser Doppler velocimetry system for unsteady separated flow research: Preliminary results [AD-A061724] 22 p0352 A79-19305
- ENVIRONMENTAL SIMULATION**
- Solar radiation simulation by means of solar simulator for the indoor testing of solar collectors 21 p0055 A79-13620
- Simulated hail impact testing of photovoltaic solar panels 21 p0098 A79-16116
- Indoor test for thermal performance evaluation on the Northrup concentrating solar collector [NASA-CR-150804] 21 p0172 A79-10515
- ENVIRONMENTAL CONTROL**
- Evaluation of control options for solar climate control systems [AIAA PAPER 78-1758] 21 p0060 A79-13859
- Energy consumption of environmental controls - Fossil fuel, steam electric generating industry 21 p0064 A79-14112
- Assessing environmental costs of energy procurement 21 p0071 A79-14682
- A microprocessor-based control system for solar heating and cooling 21 p0107 A79-16565
- Environmental control implications of generating electric power from coal. Appendix A, part 2: Coal preparation and cleaning assessment study appendix [ANL/ECT-3-APP-A-PT-2] 21 p0213 A79-13571
- ENVIRONMENTAL ENGINEERING**
- Simultaneous nitrogen oxides and sulfur dioxide removal by absorption-reduction scrubbing 21 p0066 A79-14125
- Combined environments: Technology interrelations: Proceedings of the Twenty-fourth Annual Technical Meeting, Fort Worth, Tex., April 18-20, 1978 21 p0097 A79-16076
- ENVIRONMENTAL MONITORING**
- Stabilization of power plant scrubbing slurries and fine coal refuse with the additive Calcilox 21 p0063 A79-14107
- Potential agricultural uses of fluidized bed combustion waste 21 p0064 A79-14108
- Energy and remote sensing applications 22 p0255 A79-22516
- Remote sensing and mine subsidence in Pennsylvania 22 p0303 A79-29936
- Requirements for environmental monitoring assessment, and controls for nonnuclear energy demonstration projects. Report to Congress, prepared in fulfillment of Public Law 95-39, section 113 [DOE/EV-0014] 21 p0213 A79-13573
- Guidelines for preparing environmental test plans for coal gasification plants [PB-286659/8] 21 p0232 A79-15479
- ENVIRONMENTAL QUALITY**
- An inventory of environmental impact models related to energy technologies [ORNL/FIS-147] 22 p0372 A79-21640
- ENVIRONMENTAL RESEARCH SATELLITES**
- Synchronous meteorological and geostationary operational environmental satellites battery and power system design 22 p0370 A79-21571
- ENVIRONMENTAL SURVEYS**
- Underground coal gasification research at the University of New Mexico 21 p0032 A79-10523
- Environmental Development Plan (EDP): Solar thermal power systems, 1977 [DOE/EDP-0004] 21 p0187 A79-11522
- Nonproliferation Alternative Systems Assessment Program (NASAP): Preliminary environmental assessment of thorium/uranium fuel cycle systems [ORNL/TM-6069] 21 p0192 A79-11570

## ENVIRONMENTAL TESTS

## SUBJECT INDEX

- Coal loan guarantee program (PL 94-163)  
[DOE/EIS-0004] 21 p0213 N79-13574
- Texas lignite: Environmental planning opportunities  
[PB-286870/1] 21 p0231 N79-15438
- Compilation of level 1 environmental assessment data  
[PB-286924/6] 22 p0336 N79-16439
- Environmental assessment for residual oil  
utilization  
[PB-286982/4] 22 p0336 N79-16446
- Impact prediction manual for geothermal development  
[PB-288128/2] 22 p0349 N79-18462
- A biologist's manual for the evaluation of impacts  
of coal-fired power plants on fish, wildlife and  
their habitats  
[PB-291330/9] 22 p0373 N79-21679
- ENVIRONMENTAL TESTS**
- Some aspects towards the performance evaluation  
and ensuing design components of solar collector  
systems  
21 p0130 A79-17404
- Long-term weathering effects on the thermal  
performance of the Libbey-Owens-Ford (liquid)  
solar collector  
[NASA-CR-161093] 22 p0348 N79-18450
- EPOXY RESINS**
- Composite material flywheel for the  
electric-powered passenger vehicle  
22 p0240 A79-20842
- Comparative properties of fiber composites for  
energy-storage flywheels part A. Evaluation of  
fibers for flywheel rotors --- Kevlar/epoxy and  
glass/epoxy composites  
[UCRL-80116-PT-A] 21 p0215 N79-14165
- EQUATIONS OF MOTION**
- Nonlinear dynamic response of wind turbine rotors  
[NASA-TM-78324] 21 p0195 N79-12542
- EQUILIBRIUM EQUATIONS**
- Equilibrium relations in the presence of arbitrary  
plasma diffusion in axisymmetric configurations  
22 p0257 A79-22979
- EQUILIBRIUM FLOW**
- MHD equilibrium and stability --- in tokamak devices  
21 p0078 A79-14779
- EQUIPMENT SPECIFICATIONS**
- Instrumentation at the Decade 80 solar house in  
Tucson, Arizona  
[NASA-CR-150851] 21 p0204 N79-13491
- EROSION**
- State of the art and science report on design of  
alloys resistant to high-temperature  
corrosion-erosion in coal conversion environments  
[EPRI-PP-557] 21 p0200 N79-13149
- ERROR ANALYSIS**
- Measurement of solar radiation for energy conversion  
21 p0119 A79-17305
- ESTIMATING**
- Current and projected fuel costs --- electric rate  
schedules and projected costs of fossil,  
synthetic, and nuclear fuels  
21 p0218 N79-14532
- Parameter estimation and validation of a solar  
assisted heat pump model  
22 p0332 N79-16349
- Economic impacts of a transition to higher oil  
prices --- estimation and budget allocations  
[BNL-50871] 22 p0364 N79-20927
- ESTUARIES**
- Applying NASA remote sensing data to geologically  
related regional planning problems in Tennessee  
[E79-10095] 22 p0339 N79-17289
- ETHANE**
- Comparative automotive engine operation when  
fueled with ethanol and methanol  
[HCP/W1737-01] 21 p0201 N79-13189
- ETHYL ALCOHOL**
- On future carburants. II --- alternative fuels  
from alcohols and hydrogen  
22 p0296 A79-28439
- Denaturants for ethanol/gasoline blends  
[HCP/M2098-01] 21 p0180 N79-11237
- Parameters for legislative consideration of  
bioconversion technologies  
[PB-284742/4] 21 p0194 N79-12250
- ETHYLENE COMPOUNDS**
- The anodic oxidation of ethyleneglycol at  
platinum, gold and Pt/Au-alloys in alkaline  
solution --- fuel cell electrocatalysis  
21 p0037 A79-11795

- EUROPE**
- Energy policy of the European Economic Community  
22 p0282 A79-26403
- EUROPEAN SPACE PROGRAMS**
- The utilization of European space techniques for  
energy production  
[IAF PAPER 78-190] 21 p0035 A79-11287
- Energy for Europe from space  
22 p0273 A79-25605
- A review of some critical aspects of satellite  
power systems  
22 p0326 A79-31921
- European aspects of Solar Satellite Power systems  
22 p0326 A79-31923
- EVAPORATION**
- Drop formation, evaporation modelling and  
environmental assessment of JP-4 fuel jettisoned  
from aircraft  
[AIAA PAPER 79-0186] 21 p0157 A79-19585
- EVAPORATION RATE**
- Vaporization of drops of a melt of potassium  
carbonate in a medium of combustion products  
21 p0167 A79-20411
- EVAPORATIVE COOLING**
- The ClearView Solar Collector system and  
associated one and two stage evaporative cooling  
- Interim results  
[AIAA PAPER 78-1759] 21 p0061 A79-13860
- Soil cooling for geothermal electric power plants  
in the Western United States - The Raft River  
experiment  
22 p0266 A79-24240
- EVAPORATORS**
- Heat exchangers for Ocean Thermal Energy  
Conversion plants  
21 p0142 A79-17506
- EXCHANGERS**
- Energy exchanger technology applied to laser  
heated engines  
21 p0110 A79-16631
- EXHAUST GASES**
- Development of a compact gas turbine combustor to  
give extended life and acceptable exhaust  
emissions  
[ASME PAPER 78-GT-146] 21 p0033 A79-10799
- Simultaneous nitrogen oxides and sulfur dioxide  
removal by absorption-reduction scrubbing  
21 p0066 A79-14125
- Source emissions factors for refuse derived fuels  
21 p0082 A79-15084
- Motor vehicle lead emissions in the United States  
- An analysis of important determinants,  
geographic patterns and future trends  
21 p0113 A79-16745
- Advanced emissions control and test facility of  
the Electric Power Research Institute  
21 p0115 A79-17249
- The influence of lead compounds on automotive  
exhaust catalysts  
21 p0116 A79-17253
- Assessment of current flue gas desulfurization  
technology  
21 p0145 A79-17637
- Operating experience with three 20 MW prototype  
flue gas desulfurization processes  
[ASME PAPER 78-JPGC-PWR-12] 21 p0150 A79-18098
- Emissions of nitrogen dioxide from a large  
gas-turbine power station  
21 p0152 A79-18344
- Real-time, continuous measurement of automotive  
sulfuric acid emissions  
21 p0156 A79-19359
- Combustion modification pollutant control  
techniques for industrial boilers - The  
influence of fuel oil properties and atomization  
parameters  
[ASME PAPER 78-WA/APC-13] 21 p0159 A79-19742
- Corrosion and deposits from combustion of solid  
waste. VI - Processed refuse as a supplementary  
fuel in a stoker-fired boiler  
[ASME PAPER 78-WA/FU-4] 21 p0160 A79-19788
- Trace element emissions from coal-fired power plants  
[ASME PAPER 78-WA/FU-9] 21 p0160 A79-19789
- Hydrogen enrichment for low-emission jet combustion  
22 p0244 A79-21347
- Influences on exhaust emissions from automotive  
gas turbines  
[ASME PAPER 78-GT-85] 22 p0255 A79-22338

# SUBJECT INDEX

# FAILURE ANALYSIS

- Soot and the combined cycle boiler  
[ASME PAPER 79-GT-67] 22 p0307 A79-30533
- The influence of fuel composition on smoke  
emission from gas-turbine-type combustors -  
Effect of combustor design and operating  
conditions 22 p0323 A79-31510
- A literature review-problem definition studies on  
selected toxic chemicals. Volume 1:  
Occupational health and safety aspects of diesel  
fuel and white smoke generated from it  
[AD-A056018] 21 p0192 A79-11686
- National Emissions Data System (NEDS) fuel use  
report (1974) 21 p0194 A79-12251
- Nitrogen oxide air pollution. Volume 2, part 1:  
Control technology. A bibliography with abstracts  
[NTIS/PS-78/0971/8] 21 p0199 A79-12591
- Flue gas desulfurization system capabilities for  
coal-fired steam generators, volume 1.  
Executive summary 21 p0200 A79-12606
- Utilization of waste heat in trucks for increased  
fuel economy [NASA-TM-79966] 21 p0215 A79-13937
- Effect of swirler-mounted mixing venturi on  
emissions of flame-tube combustor using jet A fuel  
[NASA-TP-1393] 21 p0215 A79-14099
- Air quality assessment of particulate emissions  
from diesel-powered vehicles  
[PB-286172/2] 21 p0223 A79-14641
- Performance characteristics of automotive engines  
in the United States. First Series: Report No.  
14 1975 Mazda Rotary 79 CID (1.1 liters), 4V ---  
fuel consumption and emissions [PB-286074/0] 21 p0226 A79-15304
- Performance characteristics of automotive engines  
in the United States. First series: Report no.  
15 1975 Dodge Colt 98 CID (1.6 liters), 2V  
[PB-286075/7] 21 p0226 A79-15305
- Performance characteristics of automotive engines  
in the United States. Second series: Report  
no. 5 1977 Ford 140 CID (2.3 liters), 2V ---  
fuel consumption and exhaust gases [PB-286076/5] 21 p0227 A79-15306
- Performance characteristics of automotive engines  
in the United States Third series: Report No. 1  
1977 Volvo 130 CID (2.1 liters), P.I. --- fuel  
consumption and exhaust gases [PB-286077/3] 21 p0227 A79-15307
- Performance characteristics of automotive engines  
in the United States. First series, report no.  
16: 1975 121 CID (2.0 liters), P.I. [PB-286297/7] 21 p0227 A79-15311
- Performance characteristics of automotive engines  
in the United States. First series, report no.  
18: 1976 Ford CID (6.6 liters), 2V --- fuel  
consumption and exhaust gases [PB-286299/3] 21 p0227 A79-15313
- Performance characteristics of automotive engines  
in the United States. First series, report no.  
19: 1975 Ford Windsor 351 CID (5.7 liters), 2V  
[PB-286300/9] 21 p0228 A79-15314
- Effects of low ambient temperature on the exhaust  
emissions and fuel economy of 84 automobiles in  
Chicago [PB-288400/5] 22 p0355 A79-19488
- Health effects associated with diesel exhaust  
emissions, literature review and evaluation  
[PB-289817/9] 22 p0364 A79-20727
- Evaluation of dry sorbents and fabric filtration  
for PGD (Flue Gas Desulfurization)  
[PB-289921/9] 22 p0373 A79-21661
- EXHAUST SYSTEMS**
- Recent operating experience of the Wellman-Lord  
PGD process on a coal-fired boiler --- flue gas  
desulfurization 21 p0065 A79-14120
- The Research-Cottrell/Bahco SO2 and particulate  
removal system at Rickenbacker Air Force Base  
21 p0065 A79-14122
- EXPERIMENTAL DESIGN**
- Acceleration of solar heating application via  
improved data evaluation 21 p0087 A79-15829
- Parametric study of two planar high power flexible  
solar array concepts [NASA-CR-157841] 21 p0205 A79-13501
- EXPLORATION**
- Microcrack technology for geothermal exploration  
and assessment [PB-290173/4] 22 p0367 A79-21530
- EXPLOSIVES**
- Permeability enhancement using explosive techniques  
--- georesources recovery techniques 21 p0005 A79-10048
- EXPONENTS**
- Role of the diode exponential factor in CdS solar  
cells 21 p0123 A79-17348
- EXPOSURE**
- Long term weathering effects on the thermal  
performance of the sunworks (liquid) solar  
collector [NASA-CR-150899] 22 p0341 A79-17328
- EXTERNAL COMBUSTION ENGINES**
- The external combustion steam injected gas turbine  
for cogeneration 21 p0012 A79-10100
- EXTREMUM VALUES**
- Theoretical upper limit to the conversion  
efficiency of solar energy 21 p0042 A79-11876
- EXTRUDING**
- Continuous extrusion of coal --- plastic  
fluidizing process 22 p0282 A79-26372
- F**
- FABRICATION**
- On-orbit fabrication and assembly of large space  
structural subsystems [IAP PAPER 78-192] 21 p0035 A79-11288
- Preparation and ionic conductivity of H3O+/+ beta  
alumina --- for hydrogen-oxygen fuel cells  
21 p0040 A79-11821
- A pilot line for the production of large area  
Cu/x/S-CdS solar cells 21 p0124 A79-17351
- Design and fabrication of silicon solar cells for  
concentrated light 21 p0124 A79-17352
- Design fabrication and testing of three meter  
diameter parabolic dish heliostat system 21 p0135 A79-17997
- Fabrication and assembly considerations for a base  
load MHD superconducting magnet system 22 p0235 A79-20534
- Recent developments in low cost silicon solar  
cells for terrestrial applications --- sheet  
production methods 22 p0239 A79-20821
- Wind-turbine-generator rotor-blade concepts with  
low-cost potential 22 p0240 A79-20828
- An operating 200 kW horizontal axis wind turbine  
22 p0240 A79-20829
- Silicon solar cells, volume 3. Citations from the  
NTIS data base [NTIS/PS-78/1115/1] 21 p0212 A79-13555
- Silicon solar cells, volume 2. Citations from the  
NTIS data base [NTIS/PS-78/1116/9] 21 p0212 A79-13556
- Fabrication and testing of silver-hydrogen cells  
[NASA-CR-159431] 22 p0334 A79-16374
- An improved solar panel and method for fabricating  
the same [NASA-CAS2-NPO-14490-1] 22 p0348 A79-18445
- FACILITIES**
- Solar thermal test facility experiment manual  
[SAND-77-1173] 21 p0221 A79-14568
- FACTOR ANALYSIS**
- Acceleration of solar heating application via  
improved data evaluation 21 p0087 A79-15829
- FAILURE ANALYSIS**
- Evaluation of methods for analyzing silver-zinc  
cells 21 p0010 A79-10085
- Optics in adverse environments; Proceedings of the  
Seminar, San Diego, Calif., August 25, 26, 1977  
21 p0044 A79-12037
- A status of the 'Alpha-ply' composite flywheel  
concept development 22 p0241 A79-20843

## FAILURE MODES

- Failure analysis in coal conversion systems ---  
pilot plant for liquefaction 22 p0266 A79-24137
- FAILURE MODES**  
User experience with on-road electric vehicles in  
the U.S.A. and Canada 21 p0009 A79-10080
- PAR ULTRAVIOLET RADIATION**  
Application of electron beams in space for energy  
storage and optical beam generation 21 p0108 A79-16606
- PARADAY EFFECT**  
Comparison of results of calculation of flow in an  
MHD generator with experimental data obtained on  
the N-25 device 22 p0306 A79-30392
- PARCELANDS**  
Selling solar energy as a cash crop 21 p0049 A79-12725
- FAST NUCLEAR REACTORS**  
The fast power cycle for fusion reactors 21 p0018 A79-10152
- FATIGUE TESTS**  
Fatigue impact on Mod-1 wind turbine design 22 p0240 A79-20827  
Some fatigue characteristics of nickel battery  
plaque [AD-A060370] 21 p0230 A79-15415
- FEASIBILITY ANALYSIS**  
Evolution of satellite power system /SPS/ concepts 21 p0002 A79-10023  
High temperature thermal energy storage in moving  
sand 21 p0012 A79-10103  
Status of free-piston Stirling engine/linear  
alternator power conversion system development 21 p0025 A79-10212  
Engineering analysis of in situ liquefaction of coal 21 p0032 A79-10521  
Feasibility of rocket propellant production on Mars 21 p0047 A79-12324  
A standard procedure of economic evaluation for  
energy-producing and pollution-abatement  
operations 21 p0064 A79-14109  
Solar energy for residential housing 21 p0090 A79-15857  
Solar power satellites revisited 21 p0093 A79-15898  
Impacts of the National Energy Plan on solar  
economics [CONF-771203-6] 21 p0118 A79-17294  
Investigation on the feasibility of using a  
two-phase thermosyphon for solar storage, space  
heating and cooking 21 p0121 A79-17330  
The feasibility of constructing a photoelectric  
unit utilizing effluent heat 21 p0125 A79-17358  
Technical and economic feasibility of making  
fertilizer from wind energy, water, and air 21 p0142 A79-17512  
Solar power satellites - An AIAA position paper 21 p0148 A79-17872  
Model systems in photoelectrochemical energy  
conversion 21 p0149 A79-18021  
Energy storage using the reversible oxidation of  
barium oxide 22 p0242 A79-21169  
Space reflector technology and its system  
implications [AIAA PAPER 79-0545] 22 p0273 A79-25852  
Economic feasibility of solar water and space  
heating 22 p0292 A79-27899  
Solar absorption cooling feasibility 22 p0295 A79-28358  
Feasibility study of transporting offshore  
OTEC-produced energy to shore by thermal media.  
Project 8980 [DSE/2426-19] 21 p0174 A79-10535  
Preliminary summary of the ETP conceptual studies  
[NASA-TN-78999] 21 p0183 A79-11478  
Evaluation of urethane for feasibility of use in  
wind turbine blade design [NASA-CR-159530] 22 p0360 A79-20497

## SUBJECT INDEX

- Feasibility study of solar dome encapsulation of  
photovoltaic arrays [NASA-CR-158368] 22 p0367 A79-21545
- FEDERAL BUDGETS**  
Financial/management scenarios for a satellite  
power system program [AAS PAPER 78-144] 22 p0243 A79-21259  
Statement of Doctor Robert A. Frosch,  
Administrator, National Aeronautics and Space  
Administration 21 p0224 A79-15111  
Authorizing appropriations to the National  
Aeronautics and Space Administration [H-REPT-96-52] 22 p0364 A79-20928
- FEED SYSTEMS**  
LSA large area silicon sheet task continuous  
liquid feed Czochralski growth [NASA-CR-158366] 22 p0357 A79-20281
- FEEDBACK CONTROL**  
On-line control of a large horizontal axis wind  
energy conversion system and its performance in  
a turbulent wind environment 21 p0028 A79-10236  
Dynamics and feedback control of ISX tokamak 21 p0107 A79-16559  
Optimizing solar energy systems using continuous  
flow control 21 p0138 A79-17477  
A digital control system for superconducting magnet 22 p0268 A79-24508  
A general design method for closed-loop solar  
energy systems 22 p0295 A79-28359  
Control strategy for a variable-speed wind energy  
conversion system 22 p0303 A79-29800
- FERTILIZATION**  
Petroleum plantations --- hydrocarbon fuels from  
artificial photosynthesis and plants 21 p0095 A79-15910
- FERTILIZERS**  
Technical and economic feasibility of making  
fertilizer from wind energy, water, and air 21 p0142 A79-17512
- FIBER COMPOSITES**  
Bibliographic and numeric databases for fiber  
composites and matrix materials 21 p0114 A79-16984  
Rotating strength of glass-carbon fiber-reinforced  
hybrid composite discs 21 p0165 A79-20273  
Current status of composite flywheel development 22 p0241 A79-20853
- FIBERS**  
Dual membrane hollow fiber fuel cell and method of  
operating same [NASA-CASE-NPO-13732-1] 21 p0172 A79-10513
- FIELD INTENSITY METERS**  
A time domain survey of the Los Alamos Region, New  
Mexico [LA-7657-MS] 22 p0365 A79-21248
- FIGURE OF MERIT**  
Modified silicon-germanium alloys with improved  
performance --- thermoelectric material 21 p0027 A79-10225
- FILAMENT WINDING**  
Large filament wound structures for energy and  
transportation systems --- turbine blades for  
windpowered energy systems 21 p0086 A79-15507  
Wind-turbine-generator rotor-blade concepts with  
low-cost potential 22 p0240 A79-20828
- FILE COOLING**  
Slag transport models for radiant heater of an MHD  
system [ASME PAPER 78-WA/HT-21] 21 p0161 A79-19808  
Water-cooled gas turbine technology development -  
Fuels flexibility [ASME PAPER 79-GT-72] 22 p0307 A79-30536
- FINANCE**  
Pennies a day - Financing early deployment of  
photovoltaic utility applications through a user  
subsidy [AIAA PAPER 78-1767] 21 p0061 A79-13866  
Coal loan guarantee program (PL 94-163) [DOE/EIS-0004] 21 p0213 A79-13574

# SUBJECT INDEX

# FLAT PLATES

## FINANCIAL MANAGEMENT

Risk control in the development of energy processes  
--- environment, worker and capital  
considerations in coal gasification

21 p0085 A79-15372

Costs and impacts of financial incentives for  
solar energy systems

21 p0119 A79-17296

Financial/management scenarios for a satellite  
power system program  
[AAS PAPER 78-144]

22 p0243 A79-21259

## FINITE ELEMENT METHOD

Three-dimensional effects of electrode  
configuration on diagonal MHD generator  
performance

22 p0283 A79-26523

## FINNED BODIES

Optimal profile of solar energy collectors

21 p0130 A79-17408

Optimal distribution of heat conducting material  
in the finned pipe solar energy collector

22 p0242 A79-21163

## FINS

Radiant exchange for a fin and tube solar collector

22 p0271 A79-25066

## FIRE EXTINGUISHERS

Further studies of fuels from alternate sources:  
Fire extinguishment experiments with JP-5 jet  
turbine fuel derived from shale  
[AD-A058586]

21 p0201 A79-13182

## FISHERIES

Reservoir ecosystems and western coal development  
in the upper Missouri River Basin  
[PB-287363/6]

22 p0339 A79-17309

## FISHES

Environmental assessment of the Alaskan  
Continental Shelf. Volume 2: Biological studies  
[PB-289155/4]

22 p0344 A79-17367

A biologist's manual for the evaluation of impacts  
of coal-fired power plants on fish, wildlife and  
their habitats  
[PB-291330/9]

22 p0373 A79-21679

## FISSION

Energy for the long run - Fission or fusion

22 p0256 A79-22760

## FISSIONABLE MATERIALS

Integrated safeguards information System (ISIS),  
executive summary --- nuclear power plant and  
fissionable materials security  
[PB-286869/3]

21 p0223 A79-14934

## FLAME STABILITY

Ignition/stabilization/atomization - Alternative  
fuels in gas turbine combustors

21 p0052 A79-12982

## FLAMES

Flame emissivities - Alternative fuels

21 p0052 A79-12984

## FLAT PLATES

Jet impingement solar air heater

[AIAA PAPER 78-1760]

21 p0061 A79-13861

Solar energy and the flat plate collector - An  
annotated bibliography

21 p0090 A79-15858

A graphical approach to the efficiency of  
flat-plate collectors

21 p0102 A79-16422

Solar radiation studies for utilization of  
flat-plate collectors in an equatorial region

21 p0119 A79-17311

On the use of grating or mesh selective filters to  
increase the efficiency of flat plate solar  
collectors

21 p0127 A79-17380

Optimum collection geometries for copper tube -  
copper sheet flat plate collectors

21 p0127 A79-17387

Flat plate collector dynamic evaluation

21 p0128 A79-17390

A parametric investigation on flat-plate solar  
collectors

21 p0128 A79-17391

A comparison among various flat plate collectors  
with honeycomb structures

21 p0128 A79-17392

Comparative outdoor measurements on flat-plate  
solar collectors in a metropolitan area in  
Western Germany

21 p0128 A79-17394

Performance of flat plate solar collector with  
fluid undergoing phase change

21 p0129 A79-17397

Effect of dust on flat plate collectors

21 p0129 A79-17399

Convective effects in 'slat collectors'

21 p0129 A79-17400

Simulation study of natural convection heat  
transfer in inclined air layers with application  
to solar energy collection

21 p0129 A79-17401

Some aspects towards the performance evaluation  
and ensuing design components of solar collector  
systems

21 p0130 A79-17404

Comparative performance testing of flat-plate  
solar water heaters

21 p0130 A79-17405

Thermal performance testing of flat-plate solar  
collectors

21 p0130 A79-17407

A channelled solar flat-plate booster ---  
reflector-absorber system for optimum collector  
insolation

21 p0131 A79-17413

Design and optimization of a flat plate collector  
for cooling application

21 p0132 A79-17419

Anticonvective antiradiative systems --- for solar  
collectors

21 p0132 A79-17420

Honeycomb type flat plate collectors - Experiments  
leading to drinking straw --- heat retention  
material for solar steam generation

21 p0132 A79-17424

Flat plate collector - Experimental studies and  
design data for India

21 p0132 A79-17425

Optimum tilt for the flat plate collector

21 p0132 A79-17426

Evacuated solar flat-plate collectors for economic  
applications

21 p0133 A79-17435

Theoretical and experimental yields of a solar  
heater with flat plate collectors

21 p0134 A79-17437

Comparative performance of tracking type and  
non-tracking type solar collectors

21 p0136 A79-17454

Heat transfer analysis of flat plate type domestic  
solar water heater

21 p0140 A79-17489

Calculation of flat-plate collector utilizability

21 p0149 A79-18020

A wave power machine using free floating vertical  
plates

21 p0151 A79-18104

Some aspects of the transient response of a  
flat-plate solar energy collector

21 p0153 A79-18466

Effect of physical properties of a flat plate  
solar collector cover on efficiency calculations  
- Simplifying hypotheses

21 p0164 A79-19949

Comparison of transient heat transfer models for  
flat plate collectors

22 p0242 A79-21168

Experiments with a flat plate solar water heating  
system in thermosyphonic flow

22 p0262 A79-23755

Analysis and design of air heating unglazed flat  
plate solar collectors

22 p0280 A79-26202

Heat loss characteristics of an evacuated  
plate-in-tube collector

22 p0285 A79-26818

Results and analysis of a round robin test program  
for liquid-heating flat-plate solar collectors

22 p0295 A79-28356

Ranking and evaluation of flat-plate collectors -  
Two new approaches --- for seasonal storage  
solar-heating systems

22 p0316 A79-31402

Performance analysis of a flat-plate solar  
collector using 'forge-fin' tubes

22 p0316 A79-31404

# FLAT SURFACES

# SUBJECT INDEX

- Dimensional relations for free convective heat transfer in flat-plate collectors --- solar collector heat loss 22 p0316 A79-31406
- Thermal performance evaluation of a flat-plate cylindrical parabolic concentrator and a flat-plate collector 22 p0317 A79-31408
- The honeycomb heat trap - Its application in flat plate solar collectors 22 p0322 A79-31447
- Analytical methods for evaluating two-dimensional effects in flat-plate solar collectors 21 p0181 N79-11462
- Methods for reducing heat losses from flat plate solar collectors, phase 2 [COO-2597-4] 21 p0188 N79-11533
- Provisional flat plate solar collector testing procedures [PB-283721/9] 21 p0158 N79-12571
- Flat plate solar collector design and performance. Citations from the NTIS data base [NTIS/PS-78/0840/5] 21 p0212 N79-13551
- Proposal for a representation of the quasisteady-state performance of flat-plate collectors [ASSA-SE-B21/77] 22 p0349 N79-18461
- FLAT SURFACES**
- Augmented solar energy collection using different types of planar reflective surfaces - Theoretical calculations and experimental results 22 p0242 A79-21166
- FLEXIBLE BODIES**
- Transient attitude dynamics of satellites with deploying flexible appendages 21 p0047 A79-12325
- FLIGHT CONTROL**
- Fuel conservative subsonic transport --- control surfaces activated by computers 22 p0337 N79-16874
- FLIGHT OPERATIONS**
- Energy conservation in general aviation and operation and maintenance of Avco Lycoming piston engines 21 p0048 A79-12381
- Economy in flight operations 21 p0048 A79-12383
- FLIGHT PATHS**
- Procedure for flight guidance in the terminal maneuvering area for an experimental program employing a flying test device 21 p0147 A79-17680
- FLIGHT SAFETY**
- Energy conservation in general aviation and operation and maintenance of Avco Lycoming piston engines 21 p0048 A79-12381
- FLOATS**
- A wave power machine using free floating vertical plates 21 p0151 A79-18104
- Experiences with a hydropneumatic wave power device 21 p0151 A79-18105
- The oscillating water column wave-energy device 22 p0252 A79-22223
- FLOODS**
- Applying NASA remote sensing data to geologically related regional planning problems in Tennessee [E79-10095] 22 p0339 N79-17289
- FLORIDA**
- Structuring a small national or state solar energy program 22 p0262 A79-23751
- FLOW CHARACTERISTICS**
- Comparison of results of calculation of flow in an MHD generator with experimental data obtained on the U-25 device 22 p0306 A79-30392
- FLOW DISTRIBUTION**
- Vortex sheet analysis of the Gironmill 21 p0031 A79-10278
- Regional analysis of potential water power 21 p0148 A79-17825
- The interaction of the wind field with a horizontal axis wind turbine 22 p0278 A79-26177
- Vortex sheet analysis of the Gironmill --- vertical axis wind turbine with straight blades 22 p0278 A79-26179
- Preliminary results of a field experiment to characterize wind flow through a vertical plane [PNL-2518] 21 p0203 N79-13322
- Liquid-fluidized-bed heat exchanger flow distribution models [ICP-1151] 22 p0369 N79-21559
- FLOW GEOMETRY**
- Some effects of flow curvature on the performance of Darrieus wind turbines [AIAA PAPER 79-0112] 21 p0156 A79-19538
- Optimization of the flow passage geometry for air heating solar collectors 22 p0316 A79-31403
- FLOW MEASUREMENT**
- Effects of test fluid, flow rate, and flow regime on solar collector thermal performance measurements 22 p0268 A79-24317
- Measurement of high-temperature, high-pressure processes [PB-284041/1] 21 p0195 N79-12424
- FLOW REGULATORS**
- The Arbonia control concept - Does flow regulation in the solar system cycle make sense --- working fluid regulation in solar heating facility 21 p0056 A79-13632
- A heat operated mechanical device to control the temperature and flow of water entering a hot water storage tank in a solar water heating system 21 p0140 A79-17487
- FLOW STABILITY**
- Viscosity stabilized solar ponds 21 p0133 A79-17430
- FLOW THEORY**
- Performance prediction methods for horizontal axis wind turbines 21 p0045 A79-12244
- FLOW VELOCITY**
- Flow rate calibration for solar heating and cooling system evaluation 21 p0089 A79-15845
- On the flow of a conducting fluid between parallel disks with a transverse magnetic field. I - A theoretical investigation on a nonequilibrium plasma flow as a compressible inviscid fluid 21 p0156 A79-19445
- Measured air flow rates through microorifices and flow prediction capability [PB-286868/5] 21 p0217 N79-14344
- FLOW VISUALIZATION**
- Solids mixing and fluidization characteristics in a tube filled bed --- of fluidized bed coal combustion 21 p0008 A79-10070
- FLUES**
- Evaluation of dry sorbents and fabric filtration for PGD (Flue Gas Desulfurization) [PB-289921/9] 22 p0373 N79-21661
- FLUID BOUNDARIES**
- Conditions for absolute stability of salt gradient solar ponds 21 p0133 A79-17431
- FLUID DYNAMICS**
- Controlled utilization of coal slag in the MHD topping cycle 21 p0081 A79-14936
- Closed cycle gas turbines, volume 1 [VKI-LS-100-VOL-1] 22 p0331 N79-16260
- Large closed-cycle gas turbine plant [GA-A-14311] 22 p0331 N79-16261
- FLUID FILMS**
- Energy conservation through sealing technology 22 p0237 A79-20700
- Heat transfer in a solar radiation absorbing fluid layer flowing over a substrate 22 p0281 A79-26204
- FLUID FILTERS**
- A model for coal fly ash filtration 22 p0296 A79-28389
- FLUID FLOW**
- Comparison of results of calculation of flow in an MHD generator with experimental data obtained on the U-25 device 22 p0306 A79-30392
- MHD generator duct flow with cross stream dependent fluid properties 22 p0336 N79-16668



# SUBJECT INDEX

# FLYWHEELS

## FLUID INJECTION

- The external combustion steam injected gas turbine for cogeneration 21 p0012 A79-10100
- Analytical modelling of oil recovery by steam injection 22 p0358 N79-20434

## FLUID MECHANICS

- Heat transfer - A review of 1977 literature 21 p0155 A79-18973
- Performance of a hydraulic air compressor for use in Compressed Air Energy Storage power systems 22 p0280 A79-26191

## FLUID POWER

- Fluids engineering in advanced energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978 22 p0278 A79-26176

## FLUIDICS

- An air-modulated fluidic fuel-injection system --- automobile fuel management [ASME PAPER 78-WA/DSC-21] 21 p0159 A79-19766

## FLUIDIZED BED PROCESSORS

- Process development for the Westinghouse advanced fluidized-bed coal gasification system 21 p0006 A79-10058
- Theoretical studies of coal pyrolysis in an entrained bed flow reactor 21 p0007 A79-10063
- Fluidized-bed combustion of low-quality fuels 21 p0007 A79-10066
- A review of the PFBC combined cycle and its influence on gas turbine design parameters --- Pressurized Fluidized Bed Combustion 21 p0007 A79-10067
- Conceptual design and cost estimate 600 MWe coal fired fluidized-bed combined cycle power plant 21 p0008 A79-10068
- Factors limiting limestone utilization efficiency in fluidized-bed combustors --- in determining sulfur dioxide emission level 21 p0008 A79-10069

- Solids mixing and fluidization characteristics in a tube filled bed --- of fluidized bed coal combustion 21 p0008 A79-10070

- Circulating-bed boiler concepts for steam and power generation 21 p0008 A79-10071

- Preliminary controller evaluation for the MERC/CTIU using a mathematical process model --- of Component Test and Integration Unit in fluidized bed combustion 21 p0008 A79-10073

- Pressurized fluidized-bed combustion/component test and integration unit preliminary design report 21 p0008 A79-10076

- Low-Btu gas from the IGT ash-agglomeration gasification process 21 p0009 A79-10077

- Heat exchanger designs for coal-fired fluidized beds 21 p0009 A79-10079

- Fluid-bed carbonization/desulfurization of Illinois coal by the Clean Coke Process - PDU studies --- Process Development Unit 21 p0045 A79-12121

- Potential agricultural uses of fluidized bed combustion waste 21 p0064 A79-14108

- Limestone SO<sub>2</sub> reactivity and causes for reactivity loss during multi cycle utilization 21 p0065 A79-14121

- Investigation of the corrosion performance of boiler, air heater, and gas turbine alloys in fluidized combustion systems 21 p0080 A79-14931

- Corrosion of superalloys, inconels, and stainless steels by the products from fluidized-bed coal combustion 21 p0080 A79-14932

- Commercialization of fluidized-bed combustion systems by the State of Ohio 21 p0096 A79-15923

- Westinghouse fluidized bed coal gasification system - Experience and plans 21 p0096 A79-15924

## Advances in fluidized bed gasification process development

- 21 p0145 A79-17633
- Recent developments in pressurized fluidized bed coal combustion research [AIAA PAPER 79-0190] 21 p0157 A79-19589

- A theoretical study of wood gasification processes 22 p0257 A79-22923

- Emissions from pressurized fluidized-bed combustion processes 22 p0261 A79-23640

- Failure analysis in coal conversion systems --- pilot plant for liquefaction 22 p0266 A79-24137

- Burn coal cleanly in a fluidized bed - The key is in the controls 22 p0282 A79-26374

- A regenerative process for fluidized-bed combustion of coal with lime additives 22 p0297 A79-28984

- The application of indirectly fired open cycle gas turbine systems utilizing atmospheric pressure fluidized bed combustors to industrial cogeneration situations [ASME PAPER 79-GT-16] 22 p0306 A79-30510

- Fluidized-bed combustion test of low-quality fuels: Texas lignite and lignite refuse [NERC/RI-78/3] 21 p0175 A79-10543

- Environmental assessment of solid residues from fluidized-bed fuel processing [PB-282940/6] 21 p0179 A79-10968

- Economics of fuel gas from coal: An update including the British Gas Corporation's slagging gasifier [EPRI-AP-782] 21 p0180 A79-11238

- Technical notes for the conceptual design for an atmospheric fluidized-bed direct combustion power generating plant [NCP/T2583-01/2] 21 p0203 A79-13280

- Fluidized bed gas turbine experimental unit for MUIS applications [ORNL/RUD/MUIS-32] 21 p0220 A79-14564

- Fluidized bed gas turbine experimental unit for MUIS applications [ORNL/RUD/MUIS-33] 21 p0221 A79-14575

- Modelling and control of a fluidized bed gasifier 22 p0332 A79-16345

- Compilation of level 1 environmental assessment data [PB-286924/6] 22 p0336 A79-16439

- Fluidized-bed combustion 22 p0347 A79-18365

- Simulation of fluidized bed coal combustors [NASA-CR-159529] 22 p0359 A79-20487

- Liquid-fluidized-bed heat exchanger flow distribution models [ICP-1151] 22 p0369 A79-21559

## FLUORIDES

- A feasibility study of inorganic oxide-fluoride compositions for thermal energy storage applications [AD-A059001] 21 p0196 A79-12559

## FLUOROHYDROCARBONS

- The preparation of some novel electrolytes: Synthesis of partially fluorinated alkane sulfonic acids as potential fuel cell electrolytes [AD-A056278] 21 p0184 A79-11483

## FLUTTER

- Aeroelastic wind energy converter 21 p0047 A79-12275

## FLYWHEELS

- Laboratory evaluation of a composite flywheel energy storage system 21 p0013 A79-10110

- The propulsion of vehicles by a flywheel 21 p0031 A79-10452

- Flywheels for vehicles --- auxiliary power in electric automobiles 21 p0092 A79-15885

- Flywheel energy storage system for JT-60 toroidal field coil 21 p0112 A79-16729

- Mechanical energy storage system for a 10 KWe solar power pack 21 p0121 A79-17329

- Spatial oscillations of a solid body carrying a low-power flywheel motor --- dual spin spacecraft motion control 21 p0148 A79-17792

Optimal control of on-board and station flywheel storage for rail transit systems 21 p0148 A79-17822

Optimal control of on-board and station flywheel storage for rail transit systems [ASME PAPER 78-WA/DSC-32] 21 p0159 A79-19771

On vibration of a thick flexible ring rotating at high speed --- for flywheel energy storage 22 p0235 A79-20511

A composite-rim flywheel design 22 p0240 A79-20840

Composite material flywheel for the electric-powered passenger vehicle 22 p0240 A79-20842

A status of the 'Alpha-ply' composite flywheel concept development 22 p0241 A79-20843

Flywheel energy accumulators for road vehicles 22 p0241 A79-20845

Composite material flywheels for energy storage on electricity supply systems 22 p0241 A79-20852

Current status of composite flywheel development 22 p0241 A79-20853

An introduction to the variable inertia flywheel [VIP/ [ASME PAPER 79-APM-5] 22 p0298 A79-29064

Application of kinetic energy storage to transportation systems --- flywheels 22 p0299 A79-29337

A flywheel energy storage and conversion system for solar photovoltaic applications [ASME PAPER 79-SOL-1] 22 p0307 A79-30539

Rotatable mass for a flywheel [NASA-CASE-MFS-23051-1] 21 p0172 A79-10422

Study of flywheel energy storage Volume 1: Executive summary [PB-282652/7] 21 p0176 A79-10555

Study of flywheel energy storage. Volume 2: Systems analysis [PB-282653/5] 21 p0176 A79-10556

Study of flywheel energy storage. Volume 3: System mechanization [PB-282654/3] 21 p0177 A79-10557

Study of flywheel energy storage. Volume 4: Life-cycle costs [PB-282655/0] 21 p0177 A79-10558

Study of flywheel energy storage. Volume 5: Vehicle tests [PB-282656/8] 21 p0177 A79-10559

A study of flywheel energy storage for urban transit vehicles [PB-282929/9] 21 p0177 A79-10563

Study of heat engine/flywheel: Hybrid propulsion configuration with electrical transmission system. Phase 2: Design definition [ALO-41/2] 21 p0185 A79-11493

Design and applications of flywheels. Citations from the NTIS data base [NTIS/PS-78/0997/3] 21 p0190 A79-11550

Design and applications of flywheels. Citations from the engineering index data base [NTIS/PS-78/0998/1] 21 p0190 A79-11551

Comparative properties of fiber composites for energy-storage flywheels part A. Evaluation of fibers for flywheel rotors --- Kevlar/epoxy and glass/epoxy composites [UCRL-80116-PT-A] 21 p0215 A79-14165

Energy and Technology Review, June 1978 --- composite materials for flywheels, shale oil recovery, and seismic safety at nuclear power plants [UCRL-52000-78-6] 21 p0215 A79-14168

Flywheel components for satellite applications [AD-A060586] 21 p0226 A79-15145

Development of a high energy storage flywheel module [AD-A060351] 21 p0230 A79-15413

Development of a satellite flywheel family operating on one active axis magnetic bearings 22 p0366 A79-21392

Wayside energy storage summary. Volume 1: Summary [DOT-TSC-PRA-79-7-1-VOL-1] 22 p0370 A79-21563

**POCI**

Flux-redistribution in the focal region of a planar Fresnel ring mirror --- solar furnace design 22 p0263 A79-23764

**FOCUSING**

Pive MW solar thermal test facility heliostat focus and alignment system 21 p0043 A79-11972

Nonimaging solar concentrators 21 p0043 A79-11973

Development of energetic neutral beams to the megawatt power level for controlled thermonuclear research 21 p0054 A79-13439

An analysis of a cylindrical parabolic focussing collector for distributed collector power system 21 p0134 A79-17442

Solar thermal electric power systems - Comparisor of line-focus collectors 22 p0263 A79-23758

**FOIL BEARINGS**

Poil type bearings for the Chrysler Automotive Gas Turbine Engine Program - Development and operational experiences [SAE PAPER 790109] 22 p0314 A79-31956

**FOLDING STRUCTURES**

Flexible roll-out solar generators - Energy sources for future high-power space missions [DGLR PAPER 78-165] 21 p0063 A79-14056

**FORCE DISTRIBUTION**

Effect of force field nonuniformity on flow in an MHD channel 21 p0101 A79-16365

**FORCED CONVECTION**

Buoyancy effects in a solar regenerator --- for air dehumidifier absorbent solutions 22 p0262 A79-23752

**FORCED VIBRATION**

A theory for wave-power absorption by two independently oscillating bodies 22 p0259 A79-23307

**FORECASTING**

Current and projected fuel costs --- electric rate schedules and projected costs of fossil, synthetic, and nuclear fuels 21 p0218 A79-14532

**FOREST MANAGEMENT**

Forest residues as an alternate energy source 21 p0072 A79-14689

FLAME: Forestry Lands Allocated for Managing energy. Feasibility study [AD-A059993] 21 p0217 A79-14507

Identification of wood energy resources in central Michigan [NASA-CR-158130] 22 p0347 A79-18424

**FORESTS**

Advanced processes for more efficient use of forest products residual material 21 p0096 A79-15919

**FOSSIL FUELS**

Permeability enhancement using explosive techniques --- georesources recovery techniques 21 p0005 A79-10048

Geothermal preheating in fossil-fired steam power plants. 21 p0014 A79-10118

Fossil superheating in geothermal steam power plants 21 p0014 A79-10122

The fossil fuel cost of solar heating 21 p0022 A79-10180

Prospects of thermionic power systems 21 p0026 A79-10220

Energy consumption of environmental controls - Fossil fuel, steam electric generating industry 21 p0064 A79-14112

A systems study of our energy problems 21 p0074 A79-14704

Hybrid fossil-geothermal power plants 21 p0096 A79-15920

High-temperature oxidizer preheater --- for fossil fuel MHD energy conversion 21 p0106 A79-16487

Fuels and combustion --- for open cycle MHD system 21 p0106 A79-16488

Perspectives on energy: Issues, ideas, and environmental dilemmas /2nd edition/ --- Book 21 p0147 A79-17646

Coal - Meeting the energy challenge 21 p0147 A79-17647

Lignite - Abundant raw material of the future 22 p0296 A79-28438

# SUBJECT INDEX

# FUEL CELLS

- Electrical induction heating of solid fossil fuels  
in situ - Some estimates 22 p0304 A79-30215
- Benefits of solar/fossil hybrid gas turbine systems  
[ASME PAPER 79-GT-38] 22 p0309 A79-30554
- Net energy analysis of five energy systems  
[ORAU/IEA(R)-77-12] 21 p0174 A79-10534
- Comprehensive overview of winter energy data  
bulletins 21 p0177 A79-10565
- [PB-282787/1] 21 p0177 A79-10565
- Ceramic technology readiness program  
[FE-2664-7] 21 p0180 A79-11223
- An assessment of mercury emissions from fossil  
fueled power plants 21 p0213 A79-13592
- [PB-285227/5] 21 p0213 A79-13592
- Bureau of Mines research 1977. A summary of  
significant results in mining, metallurgy, and  
mineral economics 21 p0217 A79-14521
- [PB-284743/2] 21 p0217 A79-14521
- Current and projected fuel costs --- electric rate  
schedules and projected costs of fossil,  
synthetic, and nuclear fuels 21 p0218 A79-14532
- FRACTURE MECHANICS**
- Fracture research in Canada 21 p0144 A79-17530
- FRACTURING**
- Study of acoustic and microseismic emissions  
associated with a hydraulic fracture ---  
geothermal energy utilization 21 p0076 A79-14744
- FRAGMENTATION**
- The LASH /laser-ash/ particulate fragmentation  
removal concept for coal fired turbine power  
plants 21 p0009 A79-10078
- FRANCE**
- Improvement of direct-current electrical  
prospecting methods for the geothermal  
investigation of the Rhine Graben 21 p0075 A79-14734
- Underground gasification of coal at deep levels -  
Perspectives and problems 21 p0156 A79-19401
- Solar houses in Blagnac /Blagnac, Haute-Garonne,  
France/ 22 p0276 A79-25937
- FREE BOUNDARIES**
- The effect of limiters and current profile on  
elliptic free-boundary MHD equilibria 22 p0291 A79-27881
- FREE CONVECTION**
- Convective effects in 'slat collectors'  
21 p0129 A79-17400
- Simulation study of natural convection heat  
transfer in inclined air layers with application  
to solar energy collection 21 p0129 A79-17401
- Natural convection heat transfer in small and  
moderate aspect ratio enclosures - An  
application to flat plate collectors 22 p0281 A79-26206
- Dimensional relations for free convective heat  
transfer in flat-plate collectors --- solar  
collector heat loss 22 p0316 A79-31406
- FREON**
- A small solar power plant with a freon turbine  
21 p0141 A79-17501
- Design of a freon jet pump for use in a solar  
cooling system [ASME PAPER 78-WA/SOL-15] 21 p0164 A79-19847
- FREQUENCY DISTRIBUTION**
- Frequency distribution of wind speed near the  
surface 21 p0165 A79-20139
- FREQUENCY MULTIPLIERS**
- Frequency doubling of a solar pumped Nd:YAG laser  
21 p0044 A79-12062
- FREQUENCY SYNCHRONIZATION**
- On the use of eddy-current couplings in  
wind-driven synchronous machines 21 p0113 A79-16742
- Induction-generator/synchronous-condenser system  
for wind-turbine power 22 p0286 A79-27219
- FRESNEL LENSES**
- Photovoltaic concentrating array 21 p0021 A79-10172
- Tracking high temperature collectors 21 p0090 A79-15856
- High temperature solar collector of optical  
concentration - Non-focusing lens with secondary  
concentrator 21 p0135 A79-17448
- Design, construction and performance of Fresnel  
lens for solar energy collection 21 p0136 A79-17456
- Efficient Fresnel lens for solar concentration  
22 p0285 A79-26816
- Solar energy concentrator design and operation.  
Citations from the NTIS data base  
[NTIS/PS-78/0838/9] 21 p0178 A79-10566
- Performance characteristics of a 1.8 by 3.7 meter  
Fresnel lens solar concentrator  
[NASA-TM-78222] 22 p0360 A79-20495
- FRESNEL REFLECTORS**
- Flux-redistribution in the focal region of a  
planar Fresnel ring mirror --- solar furnace  
design 22 p0263 A79-23764
- FUEL CAPSULES**
- Cryogenic pellets for laser-fusion research -  
Theoretical and practical considerations 21 p0085 A79-15334
- Point-contact conduction-cooling technique and  
apparatus for cryogenic laser-fusion pellets  
21 p0085 A79-15335
- Fuel content characterization and pressure  
retention measurements of DT-filled laser fusion  
microballoon targets 22 p0258 A79-23034
- FUEL CELLS**
- Heat transfer in phosphoric acid fuel cell stacks  
21 p0010 A79-10091
- Advances in lower cost phosphoric acid fuel cells  
21 p0010 A79-10092
- The anodic oxidation of ethyleneglycol at  
platinum, gold and Pt/Au-alloys in alkaline  
solution --- fuel cell electrocatalysis  
21 p0037 A79-11795
- Recent advances in electrocatalysis and their  
implications for fuel cells 21 p0038 A79-11807
- On the mechanism of the electrocatalytic oxygen  
reduction with particular regard to metal chelates  
--- in fuel cell electrodes 21 p0038 A79-11808
- O2 reduction kinetics in concentrated acids --- in  
fuel cells 21 p0038 A79-11809
- Fuel cell electrocatalysis - Where have we failed  
21 p0039 A79-11810
- Growth of refractory oxide layers by  
electrochemical vapor deposition /EVD/ at  
elevated temperatures --- for fuel cells  
21 p0039 A79-11812
- Electrochemical characteristics of ZrO2-Y2O3 solid  
electrolytes for fuel cells 21 p0039 A79-11813
- ERDA fuel cell programs 21 p0039 A79-11814
- The state-of-the-art of hydrogen-air phosphoric  
acid electrolyte fuel cells 21 p0039 A79-11815
- Analysis of electrolyte shunt currents in fuel  
cell powerplants 21 p0039 A79-11816
- Molten carbonate fuel cell systems - Status and  
potential 21 p0039 A79-11817
- Effects of sintering on porous fuel cell electrodes  
21 p0039 A79-11818
- Partial processes and transport parameters in  
molten carbonate fuel cell operation 21 p0040 A79-11819
- Thin film high temperature solid electrolyte fuel  
cells 21 p0040 A79-11820
- Molten-carbonate CO2 concentrator - Preliminary  
experiments [ASME PAPER 78-ENAS-2] 21 p0048 A79-12551
- Fuel-cell power plants 21 p0068 A79-14398
- Fuel cell on-site integrated energy system  
parametric analysis of a residential complex  
21 p0081 A79-14947

# FUEL COMBUSTION

# SUBJECT INDEX

- Role and status of dispersed electric utility fuel cell power plants 21 p0093 A79-15894
- Development of central station power plants integrated with coal gasifiers --- utilizing molten-carbonate fuel cells 21 p0093 A79-15895
- Compatibility of direct energy storage devices with ac. processing power system components 21 p0111 A79-16728
- Development of a 1 kW fuel cell aggregate with acid electrolyte 21 p0148 A79-17994
- Mass transfer in a current source during circulation of the mixture driven by gaseous reaction products --- in fuel cell 21 p0164 A79-19851
- Steady-state composition profiles in mixed molten salt electrochemical devices. II - Molten carbonate fuel cell analogs 22 p0305 A79-30333
- Technology status: Batteries and fuel cells 21 p0170 N79-10132
- Technology status: Fuel cells and electrolysis cells 21 p0170 N79-10133
- Dual membrane hollow fiber fuel cell and method of operating same [NASA-CASE-WFO-13732-1] 21 p0172 N79-10513
- The preparation of some novel electrolytes: Synthesis of partially fluorinated alkane sulfonic acids as potential fuel cell electrolytes [AD-A056278] 21 p0184 N79-11483
- High energy metal hydride fuel cell power source [AD-A056491] 21 p0184 N79-11485
- Fuel cell on-site integrated energy system parametric analysis of a residential complex [NASA-TM-78996] 21 p0193 N79-11955
- Definition of chemical and electrochemical properties of a fuel cell electrolyte [AD-A058795] 21 p0206 N79-13503
- Improved anodes for liquid hydrocarbon fuel cell [AD-A058456] 21 p0206 N79-13504
- Evaluation and optimization of Solid Polymer Electrolyte (SPE) fuel cells [AD-A058380] 21 p0206 N79-13505
- Materials for fuel cells [PB-285360/4] 21 p0212 N79-13553
- Optimization of PtDoped KOCITE (trade name) electrodes in H3PO4 fuel cells [AD-A061242] 22 p0342 N79-17340
- Development of high temperature fuel cell battery [BHPT-PB-77-17] 22 p0342 N79-17344
- Venture analysis case study for on-site fuel cell energy systems [PCR-0783-VOL-1] 22 p0361 N79-20505
- Thin film battery/fuel cell power generating system [CONS/1197-9] 22 p0369 N79-21556
- Multistack nickel-hydrogen units 22 p0371 N79-21610
- Solid Polymer Electrolyte (SPE) fuel cell technology program [NASA-CR-160159] 22 p0371 N79-21622
- FUEL COMBUSTION**
- Fluidized-bed combustion of low-quality fuels 21 p0007 A79-10066
- A review of the PFBC combined cycle and its influence on gas turbine design parameters --- Pressurized Fluidized Bed Combustion 21 p0007 A79-10067
- Solids mixing and fluidization characteristics in a tube filled bed --- of fluidized bed coal combustion 21 p0008 A79-10070
- Aspects of pulsating combustion --- gaseous methane burning system 21 p0008 A79-10072
- LAG-Process, some results of utilization in transport and mechanical engineering 21 p0030 A79-10248
- Characteristics and combustion of future hydrocarbon fuels 21 p0036 A79-11599
- Impact of future fuel properties on aircraft engines and fuel systems 21 p0036 A79-11600
- Alternative hydrocarbon fuels: Combustion and chemical kinetics; SQUID Workshop, Loyola College, Columbia, Md., September 7-9, 1977, Technical Papers 21 p0051 A79-12977
- Alternative fuels and combustion problems 21 p0051 A79-12978
- Future fuels in gas turbine engines 21 p0051 A79-12979
- Use of alternative fuels in stationary combustors 21 p0052 A79-12981
- Ignition/stabilization/atomization - Alternative fuels in gas turbine combustors 21 p0052 A79-12982
- Combustion of droplets and sprays of some alternative fuels 21 p0052 A79-12983
- Flame emissivities - Alternative fuels 21 p0052 A79-12984
- Combustion chemistry of chain hydrocarbons 21 p0052 A79-12986
- Liquid-phase reactions of vaporizing hydrocarbon fuels 21 p0052 A79-12987
- Role of aromatics in soot formation 21 p0053 A79-12988
- Kinetics of nitric oxide formation in combustion 21 p0053 A79-12989
- Emission control techniques for alternative fuel combustion 21 p0053 A79-12990
- Limestone SO2 reactivity and causes for reactivity loss during multi cycle utilization 21 p0065 A79-14121
- The fate of fuel nitrogen - Implications for combustor design and operation 21 p0080 A79-14927
- Environmental effects of burning solid waste as fuel 21 p0082 A79-15115
- Shock-tube measurements of induction and post-induction rates for low-Btu gas mixtures --- derived from shale oil retorting and coal gasification 21 p0083 A79-15245
- Commercialization of fluidized-bed combustion systems by the State of Ohio 21 p0096 A79-15923
- Fuels and combustion --- for open cycle MHD system 21 p0106 A79-16488
- The atmospheric CO2 consequences of heavy dependence on coal 21 p0107 A79-16524
- Selection of a characteristic quantity defining the self-ignition of a fuel in a stream 21 p0114 A79-16786
- A characteristic time correlation for combustion inefficiency from alternative fuels [AIAA PAPER 79-0357] 21 p0158 A79-19687
- Operation and emission of a stoker-fired boiler while burning refuse derived fuel and coal mixtures [ASME PAPER 78-WA/APC-2] 21 p0158 A79-19735
- Tests of various coals, coal-oil mixtures and refuse derived fuels in an experimental test facility [ASME PAPER 78-WA/APC-12] 21 p0158 A79-19741
- Corrosion and deposits from combustion of solid waste. VI - Processed refuse as a supplementary fuel in a stoker-fired boiler [ASME PAPER 78-WA/FU-4] 21 p0160 A79-19788
- Hydrogen enrichment for low-emission jet combustion 22 p0244 A79-21347
- Electrochemical use of biomass 22 p0254 A79-22273
- Effects of fuel properties on soot formation in turbine combustion [SAE PAPER 781026] 22 p0274 A79-25899
- A regenerative process for fluidized-bed combustion of coal with lime additives 22 p0297 A79-28984
- A new combustion system in the three-valve stratified charge engine [SAE PAPER 790439] 22 p0316 A79-31376
- Combustion of hydrogen in a supersonic flow in a channel in the presence of a pseudodiscontinuity 22 p0324 A79-31845
- Fluidized-bed combustion test of low-quality fuels: Texas lignite and lignite refuse [NERC/R1-78/3] 21 p0175 N79-10543

# SUBJECT INDEX

# FUEL CONSUMPTION

- The role of fundamental combustion in the future aviation fuels program --- carbon formation in gas turbine primary zones 21 p0202 N79-13195
- Characteristics and combustion of future hydrocarbon fuels 21 p0202 N79-13196
- Effect of swirler-mounted mixing venturi on emissions of flame-tube combustor using jet A fuel [NASA-TP-1393] 21 p0215 N79-14099
- Evaluation of future jet fuel combustion characteristics [AD-A060218] 21 p0216 N79-14231
- Alternative hydrocarbon fuels: Combustion and chemical kinetics --- synthetic aircraft fuels [AD-A061050] 22 p0338 N79-17011
- FUEL CONSUMPTION**
- H-coal products for direct application to power generation --- coal liquefaction derived fuels 21 p0006 A79-10056
- A technical analysis for cogeneration systems with potential applications in twelve California industrial plants --- energy saving heat-electricity utility systems 21 p0011 A79-10099
- The fossil fuel cost of solar heating 21 p0022 A79-10180
- Simulation study of the effect of fuel-conservative approaches on ATC procedures and terminal area capacity [SAE PAPER 780523] 21 p0031 A79-10398
- Advanced turbofan engines for low fuel consumption [ASME PAPER 78-GT-192] 21 p0033 A79-10816
- Making turbofan engines more energy efficient [ASME PAPER 78-GT-198] 21 p0033 A79-10818
- Energy conservation aircraft design and operational procedures [ONERA, TP NO. 1978-107] 21 p0036 A79-11572
- National Conference on Energy Conservation in General Aviation, 1st, Kalamazoo, Mich., October 10, 11, 1977, Proceedings 21 p0047 A79-12376
- Economy in flight operations 21 p0048 A79-12383
- Technology for aircraft energy efficiency 21 p0066 A79-14136
- Federal automobile fuel economy standards - A status report 21 p0073 A79-14693
- Energy storage - Economics and fuel conservation 21 p0153 A79-18464
- Rule of fuel management --- for airlines 21 p0155 A79-18521
- Fuel conservative aircraft engine technology 21 p0164 A79-20078
- Dynamic simulation studies of fuel conservation procedures used in terminal areas 22 p0259 A79-23581
- Fuels of the future. I --- demand and proposed sources 22 p0282 A79-26404
- Ways of improving steam-gas power plants --- fuel economy 22 p0299 A79-29298
- Emissions and economy potential of prechamber stratified charge engines [SAE PAPER 790436] 22 p0315 A79-31374
- The influence of overall equivalence ratio and degree of stratification on the fuel consumption and emissions of a prechamber, stratified-charge engine [SAE PAPER 790438] 22 p0315 A79-31375
- Prospects for reducing the fuel consumption of civil aircraft 22 p0325 A79-31911
- The NASA Aircraft Energy Efficiency program 22 p0325 A79-31912
- The impact of aeronautical sciences on other modes of transport 22 p0325 A79-31915
- End use energy consumption data base: Series 1 tables [PB-281817/7] 21 p0177 N79-10560
- Energy in transportation [PB-282928/1] 21 p0177 N79-10561
- Automotive Stirling engine development program [NASA-CR-159436] 21 p0181 N79-11406
- Federal Energy Data System (FEDS) technical documentation [PB-281815/1] 21 p0189 N79-11542
- Nonproliferation Alternative Systems Assessment Program (NASAP): Preliminary environmental assessment of thorium/uranium fuel cycle systems [ORNL/TN-6069] 21 p0192 N79-11570
- Energy efficient engine preliminary design and integration study [NASA-CR-135396] 21 p0194 N79-12084
- National Emissions Data System (NEDS) fuel use report (1974) [PB-284658/2] 21 p0194 N79-12251
- Aircraft Engine Future Fuels and Energy Conservation [AGARD-LS-96] 21 p0201 N79-13192
- Future aviation fuels fuel suppliers views 21 p0202 N79-13194
- Engine component improvement and performance retention 21 p0202 N79-13198
- Low energy consumption engines 21 p0202 N79-13199
- Energy conservation aircraft design and operational procedures 21 p0202 N79-13200
- The Otto-engine-equivalent vehicle concept [NASA-CR-157840] 21 p0203 N79-13370
- Brookhaven National Laboratory burner-boiler/furnace efficiency test project. Annual fuel use and efficiency reference manual: hydronic equipment [BNL-50816] 21 p0210 N79-13538
- A detailed analysis of the impact of onsite equipment on utility costs --- marginal costs of providing backup power for solar energy systems 21 p0218 N79-14535
- Performance characteristics of automotive engines in the United States. First Series: Report No. 14 1975 Mazda Rotary 79 CID (1.1 liters), 4V --- fuel consumption and emissions [PB-286074/0] 21 p0226 N79-15304
- Performance characteristics of automotive engines in the United States. First series: Report no. 15 1975 Dodge Colt 98 CID (1.6 liters), 2V [PB-286075/7] 21 p0226 N79-15305
- Performance characteristics of automotive engines in the United States. Second series: Report no. 5 1977 Ford 140 CID (2.3 liters), 2V --- fuel consumption and exhaust gases [PB-286076/5] 21 p0227 N79-15306
- Performance characteristics of automotive engines in the United States Third series: Report No. 1 1977 Volvo 130 CID (2.1 liters), P.I. --- fuel consumption and exhaust gases [PB-286077/3] 21 p0227 N79-15307
- Performance characteristics of automotive engines in the United States. Second series, report no. 4: 1976 Chevrolet 85 CID (1.4 liters), IV [PB-286294/4] 21 p0227 N79-15308
- Performance characteristics of automotive engines in the United States. Second series, report no. 6: 1976 Nissan diesel 198 CID (3.2 liters), P. I. [PB-286295/1] 21 p0227 N79-15309
- Performance characteristics of automotive engines in the United States. Second series, report no. 7: 1977 Ford 171 CID (2.8 liters), 2V [PB-286296/9] 21 p0227 N79-15310
- Performance characteristics of automotive engines in the United States. First series, report no. 16: 1975 121 CID (2.0 liters), P.I. [PB-286297/7] 21 p0227 N79-15311
- Performance characteristics of automotive engines in the United States. First series, report no. 17: 1975 Buick 455 CID (7.5 liters), 4V [PB-286298/5] 21 p0227 N79-15312
- Performance characteristics of automotive engines in the United States. First series, report no. 18: 1976 Ford CID (6.6 liters), 2V --- fuel consumption and exhaust gases [PB-286299/3] 21 p0227 N79-15313
- Performance characteristics of automotive engines in the United States. First series, report no. 19: 1975 Ford Windsor 351 CID (5.7 liters), 2V [PB-286300/9] 21 p0228 N79-15314
- Performance characteristics of automotive engines in the United States. First series, report no. 20: 1975 Chevrolet 350 CID (5.7 liters) with dresser variable-area venturi system [PB-286301/7] 21 p0228 N79-15315

# FUEL CONTROL

# SUBJECT INDEX

LPG in Missouri  
[PB-286329/8] 21 p0230 N79-15421

Total energy consumption for municipal wastewater treatment  
[PB-286688/7] 21 p0231 N79-15439

Energy efficient engine: Propulsion system-aircraft integration evaluation  
[NASA-CR-159488] 22 p0337 N79-16850

The planning and economic aspects of energy supply and demand in South Africa  
22 p0341 N79-17325

An analysis of fuel conserving operational procedures and design modifications for bomber/transport aircraft. Volume 1: Executive summary  
[AD-A061746] 22 p0351 N79-18969

Effects of low ambient temperature on the exhaust emissions and fuel economy of 84 automobiles in Chicago  
[PB-288400/5] 22 p0355 N79-19488

An analysis of fuel conserving operational procedures and design modifications for bomber/transport aircraft, volume 2  
[AD-A062609] 22 p0356 N79-20109

Transportation energy conservation data book, edition 3  
[ORNL-5493] 22 p0369 N79-21562

National Emissions Data Systems (NEDS) fuel use report (1975)  
[PB-290162/7] 22 p0373 N79-21670

**FUEL CONTROL**

An air-modulated fluidic fuel-injection system --- automobile fuel management  
[ASME PAPER 78-WA/DSC-21] 21 p0159 A79-19766

An air/fuel control system for the Stirling engine  
[SAE PAPER 790328] 22 p0315 A79-31369

**FUEL CORROSION**

Water-cooled gas turbine technology development - fuels flexibility  
[ASME PAPER 79-GT-72] 22 p0307 A79-30536

**FUEL FLOW**

Selection of a characteristic quantity defining the self-ignition of a fuel in a stream  
21 p0114 A79-16786

**FUEL INJECTION**

An air-modulated fluidic fuel-injection system --- automobile fuel management  
[ASME PAPER 78-WA/DSC-21] 21 p0159 A79-19766

Effect of swirler-mounted mixing venturi on emissions of flame-tube combustor using jet A fuel  
[NASA-TP-1393] 21 p0215 N79-14099

Rotary engine developments at Curtiss-Wright over the past 20 years and review of general aviation engine potential --- with direct chamber injection  
22 p0329 N79-15967

**FUEL OILS**

Scaling up coal liquids  
21 p0031 A79-10475

SRC-II - Review of development and status --- Solvent Refined Coal process for fuel oil production  
21 p0092 A79-15887

Tests of various coals, coal-oil mixtures and refuse derived fuels in an experimental test facility  
[ASME PAPER 78-WA/APC-12] 21 p0158 A79-19741

Combustion modification pollutant control techniques for industrial boilers - The influence of fuel oil properties and atomization parameters  
[ASME PAPER 78-WA/APC-13] 21 p0159 A79-19742

Synthetic oil from coal - The economic impact of five alternatives for making hydrogen from coal and steam  
22 p0262 A79-23719

Electrostatic precipitation tests with fuel oil ash  
22 p0296 A79-28390

Environmental assessment of solid residues from fluidized-bed fuel processing  
[PB-282940/6] 21 p0179 N79-10968

Environmental assessment for residual oil utilization  
[PB-286982/4] 22 p0336 N79-16446

Water-related environmental effects in fuel conversion. Volume 2: Appendices  
[PB-288874/1] 22 p0356 N79-19496

**FUEL SPRAYS**

Combustion of droplets and sprays of some alternative fuels  
21 p0052 A79-12983

**FUEL SYSTEMS**

Impact of future fuel properties on aircraft engines and fuel systems  
21 p0036 A79-11600

Effect of broadened-specification fuels on aircraft engines and fuel systems  
[AIAA 79-7008] 22 p0300 A79-29383

Study of integrated gasification combined cycle plant interaction and control  
[ASME PAPER 79-GT-60] 22 p0306 A79-30530

An air/fuel control system for the Stirling engine  
[SAE PAPER 790328] 22 p0315 A79-31369

Comparative automotive engine operation when fueled with ethanol and methanol  
[HCF/W1737-01] 21 p0201 N79-13189

Impact of future fuel properties on aircraft engines and fuel systems  
21 p0202 N79-13197

**FUEL TANKS**

Detection of internal defects in a liquid natural gas tank by use of infrared thermography  
21 p0048 A79-12507

The hydrogen/hydride energy concept  
22 p0252 A79-21717

**FUEL TESTS**

Some aspects of aircraft jet engine fuels  
21 p0035 A79-11368

Combustion of droplets and sprays of some alternative fuels  
21 p0052 A79-12983

Liquid-phase reactions of vaporizing hydrocarbon fuels  
21 p0052 A79-12987

Kinetics of nitric oxide formation in combustion  
21 p0053 A79-12989

A characteristic time correlation for combustion inefficiency from alternative fuels  
[AIAA PAPER 79-0357] 21 p0158 A79-19687

Effects of fuel properties on soot formation in turbine combustion  
[SAE PAPER 781026] 22 p0274 A79-25899

Evaluation of the application of some gas chromatographic methods for the determination of properties of synthetic fuels  
22 p0274 A79-25917

Testing to assess the affect of degraded fuel specifications on the cold start ability of a T63-A-7C0 engine  
[AIAA 79-7009] 22 p0300 A79-29384

**FUEL-ATR RATIO**

An air-modulated fluidic fuel-injection system --- automobile fuel management  
[ASME PAPER 78-WA/DSC-21] 21 p0159 A79-19766

An air/fuel control system for the Stirling engine  
[SAE PAPER 790328] 22 p0315 A79-31369

**FUELS**

Forest residues as an alternate energy source  
21 p0072 A79-14689

Public policy  
21 p0179 N79-11011

Alcohol fuels program plan  
[DOE/US-0001/2] 21 p0180 N79-11242

The emissions and fuel economy of a Detroit diesel 6-71 engine burning a 10-percent water-in-fuel emulsion  
[AD-A058550] 21 p0203 N79-13375

Proceedings of symposium on water-in-fuel emulsions in combustion --- marine diesels, boilers, and gas turbine engines  
[AD-A061503] 22 p0338 N79-17019

Thermal power systems point-focusing distributed receiver technology project. Volume 1: Executive summary  
[NASA-CR-158421] 22 p0360 N79-20492

Test procedures for the determination of the gross caloric value of refuse and refuse-derived-fuels by oxygen bomb calorimetry: Summary of the 1977 fiscal year results  
[PB-290160/1] 22 p0364 N79-21167

Synthetic fuels: Methane. Citations from the Engineering Index data base  
[NTIS/PS-79/0030/1] 22 p0365 N79-21223

# SUBJECT INDEX

# GALLIUM ARSENIDES

## FURANS

- A lithium/dissolved sulfur battery with an organic electrolyte 22 p0305 A79-30332

## FURNACES

- The Garrett Energy Research biomass gasification process 21 p0004 A79-10037
- Advanced wind furnace systems for residential and agricultural heating and electrical supply applications 21 p0028 A79-10237
- Use of alternative fuels in stationary combustors 21 p0052 A79-12981
- Brookhaven National Laboratory burner-boiler/furnace efficiency test project. Annual fuel use and efficiency reference manual: hydronic equipment [BNL-50816] 21 p0210 A79-13538

## FUSELAGES

- Aeroelastic response and stability of a coupled rotor/support system with application to large horizontal axis with turbines 22 p0332 A79-16386

## FUSION

- Economics of fusion research [COO-4181-] 21 p0193 A79-11890

## FUSION (HEATING)

- A passive integrated unit for the collection, thermal storage in fusion materials and distribution of solar energy for home heating and other applications 21 p0121 A79-17322

## FUSION REACTORS

- Hydrogen production from high temperature electrolysis and fusion reactor 21 p0015 A79-10126
- Doublet III design and construction --- Tokamak fusion research device 21 p0018 A79-10145
- Demonstration and commercial prototype tokamak reactors 21 p0018 A79-10146
- The Mirror Fusion Test Facility /MFTF/ 21 p0018 A79-10147
- Mirror fusion reactors 21 p0018 A79-10148
- Overview of inertial confinement fusion reactor designs 21 p0018 A79-10149
- CO2-laser fusion 21 p0018 A79-10150
- Compact fusion reactors using controlled imploding liners 21 p0018 A79-10151
- The fast power cycle for fusion reactors 21 p0018 A79-10152
- A calculation of linear magnetic liner fusion reactor performance 21 p0018 A79-10153
- Commercial applications of thermionic conversion using a fusion reactor energy source - A preliminary assessment 21 p0026 A79-10219
- Hybrid reactor based on laser-induced thermonuclear fusion 21 p0032 A79-10658
- Direct energy converters - Efficiency and cost estimates for two electrostatic concepts 21 p0046 A79-12266
- Liquid metal heat pipe performance in the presence of a transverse magnetic field --- for fusion reactors [ASME PAPER 78-ENAS-20] 21 p0048 A79-12569
- Development of energetic neutral beams to the megawatt power level for controlled thermonuclear research 21 p0054 A79-13439
- Fusion reactor problems --- plasma confinement and interface engineering 21 p0071 A79-14468
- Tokamak reactors for breakeven: A critical study of the near-term fusion reactor program --- Book 21 p0077 A79-14776
- Philosophy and physics of predemonstration fusion devices 21 p0078 A79-14783

- Materials problems and possible solutions for near term tokamak fusion reactors 21 p0079 A79-14790

- The impact of servicing requirements on tokamak fusion reactor design 21 p0079 A79-14793
- Large-scale cryopumping for controlled fusion 21 p0085 A79-15330
- Stimulated Raman scatter in laser fusion target chambers 21 p0155 A79-18794
- Nuclear characteristics of D-D fusion reactor blankets - Technical data 21 p0162 A79-19826
- The role of the Large Coil Program in the development of superconducting magnets for fusion reactors 22 p0236 A79-20541
- Problems in the development of high-service-life capacitative accumulators --- for fusion reactors 22 p0243 A79-21249
- An overview of design space for small fusion targets 22 p0253 A79-22241
- Energy for the long run - Fission or fusion 22 p0256 A79-22760
- The potential of fusion reactors as process heat source 22 p0284 A79-26624
- Pellet X-ray spectra for laser fusion reactor designs 22 p0291 A79-27878
- Homopolar generator energy storage for fusion reactors 22 p0304 A79-29942
- Interpretation of cyclotron radiation spectra from runaway discharges in TFR 22 p0313 A79-31185
- MHD gas turbine energy conversion for mirror fusion reactors 22 p0313 A79-31192
- Dynamic stabilization of toroidal discharges in weak longitudinal magnetic fields 22 p0324 A79-31766
- The JET project - A step towards the production of power by nuclear fusion 22 p0326 A79-31918

## FUSION-FISSION HYBRID REACTORS

- Fusion-Fission Energy Systems 21 p0017 A79-10144
- Mirror fusion reactors 21 p0018 A79-10148
- Progress in laser-fusion research 21 p0070 A79-14464
- Perspective on the fusion-fission energy concept 21 p0095 A79-15913
- The synergetics of the catalytic D-D-fusion-fission breeder 22 p0252 A79-22236
- Controlled thermonuclear fusion 22 p0287 A79-27339

## G

## GALLIUM ARSENIDES

- n-CdS/n-GaAs photoanode --- electrochemical solar cells 21 p0037 A79-11784
- Performance of a tilted solar cell under various atmospheric conditions 21 p0066 A79-14261
- Grain-boundary edge passivation of GaAs films by selective anodization --- shorting effect in solar cells 21 p0154 A79-18487
- /SH/x-GaAs polymer-semiconductor solar cells 21 p0154 A79-18504
- Temperature dependence of photovoltaic solar energy conversion for GaAs homojunction solar cell 22 p0256 A79-22768
- A two-junction cascade solar-cell structure 22 p0256 A79-22856
- High-efficiency AlGaAs/GaAs concentrator solar cells 22 p0261 A79-23710
- Series resistance effects in /GaAl/As/GaAs concentrator solar cells 22 p0273 A79-25745
- Diffusion length measurements in Schottky barrier GaAs solar cells 22 p0281 A79-26243

- Ga/1-x/Al/x/As-GaAs photovoltaic cells with multilayer structure --- heterostructure solar cell fabrication 22 p0305 A79-30258
- Measuring the quasi-Fermi level and flat band potential of an illuminated Au/n-GaAs/.6/P/.4/ anode --- for solar cells 22 p0317 A79-31411
- High performance GaAs photovoltaic cells for concentrator applications [SAND-78-7018] 21 p0187 N79-11521
- Present status of GaAs --- including space processing and solid state applications [NASA-CR-3093] 21 p0215 N79-14192
- GaAs solar cell development [NASA-CR-158090] 22 p0334 N79-16366
- GALLIUM PHOSPHIDES**
- Measuring the quasi-Fermi level and flat band potential of an illuminated Au/n-GaAs/.6/P/.4/ anode --- for solar cells 22 p0317 A79-31411
- GARBAGE**
- Chloride corrosion and its inhibition in refuse firing 21 p0080 A79-14930
- GAS ANALYSIS**
- Measurement of high-temperature, high-pressure processes [PB-284041/1] 21 p0195 N79-12424
- Pollutants from synthetic fuels production: Facility construction and preliminary tests --- coal gasification plant effluents [PB-287730/6] 22 p0339 N79-17027
- GAS BEARINGS**
- Air bearing development for a GM automotive gas turbine [SAE PAPER 790107] 22 p0314 A79-31355
- Foil type bearings for the Chrysler Automotive Gas Turbine Engine Program - Development and operational experiences [SAE PAPER 790109] 22 p0314 A79-31356
- GAS CHROMATOGRAPHY**
- Evaluation of the application of some gas chromatographic methods for the determination of properties of synthetic fuels 22 p0274 A79-25917
- Evaluation of the application of some gas chromatographic methods for the determination of properties of synthetic fuels [NASA-TN-79035] 22 p0338 N79-16930
- GAS COMPOSITION**
- Instrumentation for in situ coal gasification. II - Thermal and gas sampling diagnostic techniques 21 p0032 A79-10520
- Study of the applicability of the geochemistry of gases in geothermal prospection 21 p0075 A79-14736
- A mass and energy balance of a Wellman-Galusha gasifier --- bituminous coal conversion 22 p0283 A79-26467
- The natural and perturbed troposphere 21 p0179 N79-10636
- GAS DISCHARGES**
- Recent results from the PLT tokamak 21 p0069 A79-14453
- Measurements of plasma rotation in tokamak IT-3 22 p0252 A79-22238
- Experiments on controlling the plasma density in the TO-1 tokamak 22 p0324 A79-31762
- Experimental investigation on the discharge structure in a noble gas MHD generator [TH-78-E-79] 22 p0350 N79-18758
- GAS DISSOCIATION**
- Screening reversible reactions for thermochemical energy transfer 22 p0285 A79-26823
- GAS DYNAMICS**
- Quasi-isentropic laser engines 21 p0111 A79-16632
- GAS EVOLUTION**
- The atmospheric CO2 consequences of heavy dependence on coal 21 p0107 A79-16524
- GAS EXPANSION**
- Preliminary design of a subscale ceramic helical-rotor expander 21 p0050 A79-12849
- GAS FLOW**
- 'Local' breakdown criterion in highly ionized gas flow 21 p0049 A79-12683
- Gas-cycle solar refrigeration system performance 21 p0153 A79-18471
- Flow modeling of an atmospheric pressure, entrained-type coal gasifier 22 p0280 A79-26188
- GAS GENERATORS**
- Low-Btu gas from the IGT ash-agglomeration gasification process 21 p0009 A79-10077
- The combined reheat gas turbine/steam turbine cycle. I - A critical analysis of the combined reheat gas turbine/steam turbine cycle [ASME PAPER 79-GT-7] 22 p0306 A79-30505
- The combined reheat gas turbine/steam turbine cycle. II - The LM 5000 gas generator applied to the combined reheat gas turbine/steam turbine cycle [ASME PAPER 79-GT-8] 22 p0306 A79-30506
- GAS HEATING**
- Analysis and application of the heat pipe heat exchanger 21 p0014 A79-10117
- Cost effective optimum design of solar air heaters 21 p0127 A79-17386
- GAS LASERS**
- A new concept for solar pumped lasers 21 p0110 A79-16624
- Progress in nuclear-pumped lasers 21 p0110 A79-16627
- GAS MIXTURES**
- LAG-Process, some results of utilization in transport and mechanical engineering 21 p0030 A79-10248
- Shock-tube measurements of induction and post-induction rates for low-Btu gas mixtures --- derived from shale oil retorting and coal gasification 21 p0083 A79-15245
- Mass transfer in a current source during circulation of the mixture driven by gaseous reaction products --- in fuel cell 21 p0164 A79-19851
- Wilson parameters for the system H2, N2, CO, CO2, CH4, H2S, CH3OH, and H2O --- for cold methanol absorption in-coal gasification 22 p0282 A79-26462
- GAS PIPES**
- Problems, status, and prospects of a solar hydrogen economy 21 p0059 A79-13658
- GAS PRESSURE**
- Thermodynamics of pressure plateaus in metal-hydrogen systems 22 p0238 A79-20772
- GAS RECOVERY**
- Potential producibility and recovery of natural gas from geopressed aquifers of the Cenozoic sediments of the Gulf Coast Basin [PB-2025-3] 21 p0192 N79-11607
- Study of hydrogen recovery systems for gas vented while refueling liquid-hydrogen fueled aircraft [NASA-CR-158991] 22 p0346 N79-18057
- GAS STREAMS**
- Gas stream composition and temperature determination in a coal-fired MHD simulation facility [ASME PAPER 78-WA/HT-23] 21 p0161 A79-19810
- GAS TEMPERATURE**
- Instrumentation for in situ coal gasification. II - Thermal and gas sampling diagnostic techniques 21 p0032 A79-10520
- GAS TRANSPORT**
- Transport fuels from natural gas 22 p0292 A79-27897
- GAS TURBINE ENGINES**
- Closed Cycle Gas Turbine power generation opportunities 21 p0004 A79-10039
- Advanced industrial gas turbine cooling and high pressure compressor technology 21 p0004 A79-10041
- A review of the PFBC combined cycle and its influence on gas turbine design parameters --- Pressurized Fluidized Bed Combustion 21 p0007 A79-10067



# SUBJECT INDEX

# GAS TURBINES

The LASH /laser-ash/ particulate fragmentation removal concept for coal fired turbine power plants 21 p0009 A79-10078

Combined cycle gas turbine for an automobile application 21 p0019 A79-10157

Heat pipe central solar receiver gas turbine plant 21 p0022 A79-10178

Development of gas turbine performance seeking logic [ASME PAPER 78-GT-13] 21 p0031 A79-10257

Second-generation integrated coal gasification/combined-cycle power systems [ASME PAPER 78-GT-14] 21 p0032 A79-10778

Development of a compact gas turbine combustor to give extended life and acceptable exhaust emissions [ASME PAPER 78-GT-146] 21 p0033 A79-10799

Making turbofan engines more energy efficient [ASME PAPER 78-GT-198] 21 p0033 A79-10818

Effect of inlet temperature on the performance of a catalytic reactor 21 p0035 A79-11542

Alternative aviation turbine fuels 21 p0047 A79-12378

Current problems in the development and production of small gas turbine engines 21 p0048 A79-12529

Test and development of ceramic combustors, stators, nose cones, and rotor tip shrouds 21 p0049 A79-12821

Reliability and durability of ceramic regenerators for gas turbine applications 21 p0050 A79-12823

Designing and testing Si3N4 turbine components at Mercedes-Benz 21 p0050 A79-12830

Development of ceramic parts for a truck gas turbine at MTU 21 p0050 A79-12831

Development of multi-density silicon nitride turbine rotors 21 p0050 A79-12832

Ceramics for the advanced automotive gas turbine engine - A look at a single shaft design 21 p0050 A79-12850

Future fuels in gas turbine engines 21 p0051 A79-12979

Ignition/stabilization/atomization - Alternative fuels in gas turbine combustors 21 p0052 A79-12982

Flame emissivities - Alternative fuels 21 p0052 A79-12984

Study of a heat exchanger with heat pipes within the system of a small-scale gas-turbine engine 21 p0114 A79-16800

Technology evolution in the Allison Model 250 engine --- for helicopter propulsion 21 p0155 A79-18681

Design and development of a monorotor gas turbine auxiliary power unit [ASME PAPER 78-WA/GT-2] 21 p0160 A79-19791

Ceramic materials for vehicular gas turbine applications 21 p0165 A79-20085

Influences on exhaust emissions from automotive gas turbines [ASME PAPER 78-GT-85] 22 p0255 A79-22338

Environmental factors affecting the installation and operation of gas turbine engines in agricultural aircraft [SAE PAPER 781010] 22 p0274 A79-25892

Hot corrosion of Ni-base turbine alloys in atmospheres in coal-conversion systems 22 p0288 A79-27395

Cogeneration in Europe and the combined cycle gas turbine 22 p0297 A79-28988

Gas turbine operating and maintenance experience in Saudi Arabia 22 p0298 A79-28989

Measured effects of flow leakage on the performance of the GT-225 automotive gas turbine engine [ASME PAPER 79-GT-3] 22 p0306 A79-30502

The application of indirectly fired open cycle gas turbine systems utilizing atmospheric pressure fluidized bed combustors to industrial cogeneration situations [ASME PAPER 79-GT-16] 22 p0306 A79-30510

Soot and the combined cycle boiler [ASME PAPER 79-GT-67] 22 p0307 A79-30533

A multivariable controller for an automotive gas turbine [ASME PAPER 79-GT-73] 22 p0307 A79-30537

Air bearing development for a GM automotive gas turbine [SAE PAPER 790107] 22 p0314 A79-31355

Poil type bearings for the Chrysler Automotive Gas Turbine Engine Program - Development and operational experiences [SAE PAPER 790109] 22 p0314 A79-31356

Some design considerations of automotive gas turbines [SAE PAPER 790128] 22 p0314 A79-31360

Field experience with the Detroit Diesel Allison 404/505 industrial gas turbine engines [SAE PAPER 790129] 22 p0314 A79-31361

The influence of fuel composition on smoke emission from gas-turbine-type combustors - Effect of combustor design and operating conditions 22 p0323 A79-31510

Analytical evaluation of the impact of broad specification fuels on high bypass turbofan engine combustors [NASA-CR-159454] 21 p0200 A79-13050

Future fuels for aviation 21 p0201 A79-13193

Fluidized bed gas turbine experimental unit for MUIS applications [ORNL/HDU/MUIS-32] 21 p0220 A79-14564

Cold-air performance of free power turbine designed for 112-kilowatt automotive gas-turbine engine. 2: Effects of variable stator-vane-chord setting angle on turbine performance [NASA-TM-78993] 22 p0345 A79-17859

Tests of NASA ceramic thermal barrier coating for gas-turbine engines [NASA-TM-79116] 22 p0357 A79-20118

Evaluation of ceramics for stator application: Gas turbine engine report [NASA-CR-159533] 22 p0364 A79-21075

**GAS TURBINES**

Coal-fired gas turbine power cycles with steam injection 21 p0004 A79-10042

The external combustion steam injected gas turbine for cogeneration 21 p0012 A79-10100

Evaluation program for new industrial gas turbine materials [ASME PAPER 78-GT-145] 21 p0031 A79-10269

Ceramic components for vehicular gas turbines 21 p0034 A79-11150

A small solar power plant with a freon turbine 21 p0141 A79-17501

A reflector concentrator modified sterling engine unit and an aqua-ammonia absorber gas turbine unit for farm power needs 21 p0142 A79-17509

Emissions of nitrogen dioxide from a large gas-turbine power station 21 p0152 A79-18344

A cavity receiver design for solar heated gas turbine generating systems [ONERA, TP NO. 1978-137] 21 p0155 A79-18560

The nuclear closed-cycle gas turbine /GT-HTGR/ - A utility power plant for the year 2000 [AIAA PAPER 79-0191] 21 p0157 A79-19590

Using N2O4 in a solar gas-turbine plant 21 p0167 A79-20357

Gas turbine with waste heat utilization - Low investment costs and high fuel use efficiency 21 p0168 A79-20448

Storage peak gas-turbine power plant --- compressor for electric energy storage 22 p0268 A79-24507

Ways of improving steam-gas power plants --- fuel economy 22 p0299 A79-29298

## GAS-METAL INTERACTIONS

- The combined reheat gas turbine/steam turbine cycle. I - A critical analysis of the combined reheat gas turbine/steam turbine cycle [ASME PAPER 79-GT-7] 22 p0306 A79-30505
- The combined reheat gas turbine/steam turbine cycle. II - The LM 5000 gas generator applied to the combined reheat gas turbine/steam turbine cycle [ASME PAPER 79-GT-8] 22 p0306 A79-30506
- Investigation of the heat transfer in cylindrical receiver configurations with inner tubes [ASME PAPER 79-GT-64] 22 p0306 A79-30532
- Water-cooled gas turbine technology development - Fuels flexibility [ASME PAPER 79-GT-72] 22 p0307 A79-30536
- Benefits of solar/fossil hybrid gas turbine systems [ASME PAPER 79-GT-38] 22 p0309 A79-30554
- MHD gas turbine energy conversion for mirror fusion reactors 22 p0313 A79-31192
- Fluidized bed gas turbine experimental unit for MHD applications [ORNL/HUD/MHD-33] 21 p0221 A79-14575
- Combined cycle power generation. Citations from the WTIS data base [WTIS/PS-78/1156/5] 21 p0222 A79-14587
- Combined cycle power generation. Citations from the Engineering Index data base [WTIS/PS-78/1157/3] 21 p0222 A79-14588
- Benefits of solar/fossil hybrid gas turbine systems [NASA-TM-79083] 21 p0229 A79-15410
- Closed cycle gas turbines, volume 1 [VKI-LS-100-VOL-1] 22 p0331 A79-16260
- Large closed-cycle gas turbine plant [GA-A-14311] 22 p0331 A79-16261
- Power cycles and working fluids for low temperature heat sources 22 p0332 A79-16268
- Proceedings of symposium on water-in-fuel emulsions in combustion --- marine diesels, boilers, and gas turbine engines [AD-A061503] 22 p0338 A79-17019
- Methane utilization from coalbeds for power generation [TID-28408] 22 p0352 A79-19171
- GAS-METAL INTERACTIONS**
- Thermophoresis - Enhanced deposition rates in combustion turbine blade passages [ASME PAPER 78-WA/GT-1] 21 p0160 A79-19790
- Hydrides of rare earth-nickel compounds - Structure and formation enthalpies 22 p0250 A79-21697
- Hydrogen sorption properties in binary and pseudobinary intermetallic compounds 22 p0250 A79-21702
- Hydrogen storage in FeTi - Surface segregation and its catalytic effect on hydrogenation and structural studies by means of neutron diffraction 22 p0312 A79-31156
- GASDYNAMIC LASERS**
- Systems efficiency and specific mass estimates for direct and indirect solar-pumped closed-cycle high-energy lasers in space 21 p0110 A79-16623
- GASEOUS DIFFUSION**
- NMR studies of hydrogen relaxation and diffusion in  $TiFeH/x/$  and  $TiFe_{1-y}Mn_yH/x/$  22 p0248 A79-21684
- Hydrogen storage electrode systems 22 p0251 A79-21710
- GASEOUS FUELS**
- There is a lot of energy in digester gas . . . use it --- in municipal waste water plants 21 p0035 A79-11448
- Integrated low Btu gasification, combined cycle plant considerations and control 21 p0094 A79-15905
- Production and use of low and medium Btu gas 21 p0095 A79-15912
- Energy through solar aided bio-gas systems 21 p0125 A79-17367
- Development of the combustion chamber of an experimental MHD generator 22 p0327 A79-32105
- Gaseous fuel reactors for power systems [LA-UR-78-1437] 21 p0214 A79-13844

## SUBJECT INDEX

## GASES

- Conversion of biomass materials into gaseous products, phase 1 [SAN/1241-77/1] 21 p0171 A79-10237

## GASIFICATION

- The Garrett Energy Research biomass gasification process 21 p0004 A79-10037
- Gasification of coal liquefaction residues 21 p0006 A79-10059
- Steam raising with low-Btu gas generators and potential for other applications 21 p0072 A79-14690
- Kinetic modeling of pyrolysis and hydrogasification of carbonaceous materials --- converting wood waste char to clean fuels 21 p0179 A79-11150

## GASOLINE

- Automotive Stirling engine development program [NASA-CR-159436] 21 p0181 A79-11406
- Proposed standby gasoline rationing plan. Economic and regulatory analysis draft [DOE/EHA-0009] 21 p0214 A79-13934
- Economic impacts of a transition to higher oil prices --- estimation and budget allocations [BNL-50871] 22 p0364 A79-20927

## GENERAL AVIATION AIRCRAFT

- National Conference on Energy Conservation in General Aviation, 1st, Kalamazoo, Mich., October 10, 11, 1977, Proceedings 21 p0047 A79-12376
- Automotive engines - A viable alternative for aircraft 21 p0047 A79-12379
- Turbine engines in light aircraft 21 p0047 A79-12380
- Energy conservation in general aviation and operation and maintenance of Avco Lycoming piston engines 21 p0048 A79-12381
- Economy in flight operations 21 p0048 A79-12383
- Flying angle of attack 21 p0048 A79-12384
- Impact of fuel availability and other cost trends on general aviation 21 p0053 A79-13078
- NASA research on general aviation power plants [NASA-TM-79031] 21 p0194 A79-12086
- The rotary combustion engine: A candidate for general aviation --- conferences [NASA-CP-2067] 22 p0329 A79-15961
- General aviation energy-conservation research programs 22 p0329 A79-15963
- Development status of rotary engine at Toyo Kogyo --- for general aviation aircraft 22 p0329 A79-15964
- Update of development on the new Audi NSU rotary engine generation --- for application to aircraft engines 22 p0329 A79-15965
- Review of the Rhein-Flugzeugbau Wankel powered aircraft program --- ducted fan engines 22 p0329 A79-15966
- Rotary engine developments at Curtiss-Wright over the past 20 years and review of general aviation engine potential --- with direct chamber injection 22 p0329 A79-15967
- Engine requirements for future general aviation aircraft 22 p0329 A79-15968

## GEOCHEMISTRY

- Study of the applicability of the geochemistry of gases in geothermal prospecting 21 p0075 A79-14736
- Suggestions for a geochemical prospecting of geothermal systems - A first survey of the Italian thermal springs 21 p0075 A79-14737
- Surtrace - An airborne geochemical system --- for earth surface micro-layer exploration 22 p0255 A79-22557
- Evaluation and targeting of geothermal energy resources in the southeastern United States [VPI-SU-5648-1] 21 p0204 A79-13478

# SUBJECT INDEX

# GEO THERMAL ENERGY CONVERSION

## GEOELECTRICITY

Improvement of direct-current electrical  
prospecting methods for the geothermal  
investigation of the Rhine Graben  
21 p0075 A79-14734

## GEOLE SATELLITES

High accuracy off-shore position finding using the  
GEOLE satellite based system  
22 p0329 N79-15932

## GEOLOGICAL FAULTS

Applying NASA remote sensing data to geologically  
related regional planning problems in Tennessee  
[E79-10095] 22 p0339 N79-17289

## GEOLOGICAL SURVEYS

Suggestions for a geochemical prospecting of  
geothermal systems - A first survey of the  
Italian thermal springs  
21 p0075 A79-14737

Remote sensing and mine subsidence in Pennsylvania  
22 p0303 A79-29936

A synoptic description of coal basins via image  
processing  
[NASA-CR-157970] 21 p0204 N79-13474

Evaluation and targeting of geothermal energy  
resources in the southeastern United States  
[VPI-SU-5648-1] 21 p0204 N79-13478

Borehole geological assessment  
[NASA-CASE-WFO-14231-1] 22 p0356 N79-19521

## GEOLOGY

Applying NASA remote sensing data to geologically  
related regional planning problems in Tennessee  
[E79-10095] 22 p0339 N79-17289

Application of LANDSAT data and digital image  
processing --- Ruhr Valley, Germany  
[E79-10102] 22 p0339 N79-17291

## GEOMETRY

Mathematics of coiling in cylindrical  
electrochemical cells - The theory of a spiral  
bounded by two circles and its application to  
the spiral-wound nickel-cadmium cell  
22 p0246 A79-21489

## GEOPHYSICS

Evaluation and targeting of geothermal energy  
resources in the southeastern United States  
[VPI-SU-5648-1] 21 p0204 N79-13478

## GEOSYNCHRONOUS ORBITS

Nickel-cadmium battery reconditioning and long  
term performance in geosynchronous orbit  
spacecraft  
21 p0029 A79-10242

Solar energy via satellites and international  
cooperation  
22 p0310 A79-30952

## GEO THERMAL ENERGY CONVERSION

Geothermal preheating in fossil-fired steam power  
plants  
21 p0014 A79-10118

Performance of a 10 MW geothermal energy  
conversion test facility  
21 p0014 A79-10119

Geothermal power from salt domes  
21 p0014 A79-10120

Fossil superheating in geothermal steam power plants  
21 p0014 A79-10122

Heat exchanger design for geothermal power plants  
21 p0015 A79-10123

Hydrocarbon working fluid and operating conditions  
selection for the conventional geothermal binary  
cycle  
21 p0015 A79-10124

Effect of noncondensable gases on geothermal power  
generation  
21 p0015 A79-10125

Pollution perspective for geothermal energy  
development  
21 p0064 A79-14114

Seminar on Geothermal Energy, 1st, Brussels,  
Belgium, December 6-8, 1977, Proceedings.  
Volumes 1 & 2  
21 p0075 A79-14726

Investigation of the optimal use of geothermal  
waters for the heating of several types of  
dwelling in various European climates  
21 p0075 A79-14739

Preliminary results of the new geothermal domestic  
heating system at Creil  
21 p0075 A79-14740

Design study of a thermohydraulic loop for the  
conversion of geothermal energy /low enthalpy/  
into electricity  
21 p0076 A79-14741

Study of acoustic and microseismic emissions  
associated with a hydraulic fracture ---  
geothermal energy utilization  
21 p0076 A79-14744

Hot dry rock - A new geothermal energy source  
[ASME PAPER 78-JPGC-PWR-18] 21 p0087 A79-15673

Geothermal energy from a utility perspective ---  
Imperial Valley of Southern California  
21 p0091 A79-15880

Hybrid fossil-geothermal power plants  
21 p0096 A79-15920

Opportunities for direct use of geohat in Central  
America and other tropical countries  
21 p0097 A79-16074

Thermosyphon models for downhole heat exchanger  
applications in shallow geothermal systems  
21 p0150 A79-18092

History and development of condensers at the  
Geysers geothermal power plant  
[ASME PAPER 78-JPGC-PWR-18] 21 p0150 A79-18099

Floating dry cooling, a competitive alternative to  
evaporative cooling in a binary cycle geothermal  
power plant  
[ASME PAPER 78-WA/ENER-2] 21 p0159 A79-19775

A comparison of the performance of steam turbine  
cycles using gas contaminated geothermal steam  
[ASME PAPER 78-WA/ENER-3] 21 p0159 A79-19776

Geothermal power and water production studies at  
the University of California  
[ASME PAPER 78-WA/ENER-7] 21 p0159 A79-19778

Geothermal energy: Its past, present and future  
contributions to the energy needs of man --- Book  
22 p0252 A79-21825

The economics of geothermal energy development at  
the regional level  
22 p0256 A79-22756

Mining earth's heat - Hot dry rock geothermal energy  
22 p0258 A79-23280

East Mesa geothermal test site  
22 p0259 A79-23458

Hot dry rock - A new potential for energy  
22 p0265 A79-23832

The geothermal power station at Ahuachapán, El  
Salvador  
22 p0266 A79-24239

Soil cooling for geothermal electric power plants  
in the Western United States - The Raft River  
experiment  
22 p0266 A79-24240

Thermal conductivity of crystalline rocks  
associated with energy extraction for hot dry  
rock geothermal systems  
22 p0304 A79-30123

Hot dry rock energy project  
[LA-OR-77-2744] 21 p0175 N79-10540

Pollution control guidance for geothermal energy  
development  
[PB-282546/1] 21 p0178 N79-10604

Energy programs at The Johns Hopkins University  
Applied Physics Laboratory  
[PB-283170/9] 21 p0191 N79-11555

Non-electric applications of geothermal energy in  
six Alaskan towns  
[IDC-1622-4] 21 p0208 N79-13523

OTEC thermal resource report for Central Gulf of  
Mexico  
[TID-27951] 21 p0209 N79-13533

Comparative cost analyses: Total flow vs other  
power conversion systems for the Salton Sea  
Geothermal Resource  
[UCRL-52589] 22 p0342 N79-17337

Impact prediction manual for geothermal development  
[PB-288128/2] 22 p0349 N79-18462

Geothermal resources for aquaculture  
[PB-290345/8] 22 p0356 N79-19563

Measurement and control techniques in geothermal  
power plants  
[TREC-1312] 22 p0362 N79-20508

Demonstration of a rotary separator for two-phase  
brine and steam flows  
[TID-28519] 22 p0365 N79-21309

**GEOHERMAL RESOURCES**

Optimum design conditions for a power plant at a vapor dominated geothermal resource, Pacific Gas and Electric's The Geysers Power Plant Unit 16  
21 p0014 A79-10121

A thermodynamic study of heating with geothermal energy  
[ASME PAPER 77-WA/ENER-1] 21 p0030 A79-10253

Potential and technical utilization of renewable energy sources  
21 p0058 A79-13655

Projecting energy resource utilization - The geothermal case  
21 p0068 A79-14321

Seminar on Geothermal Energy, 1st, Brussels, Belgium, December 6-8, 1977, Proceedings. Volumes 1 & 2  
21 p0075 A79-14726

Shallow magmatic reservoirs as heat source of geothermal systems - Preliminary interpretation of data available for the Neapolitan active volcanic areas  
21 p0075 A79-14727

Magnetotelluric and geoelectric measurements for geothermal exploration in the Phlegraean Fields /preliminary results/  
21 p0075 A79-14732

Improvement of direct-current electrical prospecting methods for the geothermal investigation of the Rhine Graben  
21 p0075 A79-14734

Study of the applicability of the geochemistry of gases in geothermal prospecting  
21 p0075 A79-14736

Suggestions for a geochemical prospecting of geothermal systems - A first survey of the Italian thermal springs  
21 p0075 A79-14737

Investigation of the optimal use of geothermal waters for the heating of several types of dwelling in various European climates  
21 p0075 A79-14739

Hot dry rock - A new geothermal energy source  
21 p0087 A79-15673

Opportunities for direct use of geothermal energy in Central America and other tropical countries  
21 p0097 A79-16074

A comparison of the silica and Na-K-Ca geothermometers for thermal springs in Utah  
21 p0097 A79-16075

Hot dry rock, an abundant clean energy resource  
21 p0098 A79-16106

A methodology for assessing the potential impact on air quality resulting from geothermal resource development in the Imperial Valley  
21 p0116 A79-17262

Remote sensing use in hydraulic planification in Mexico  
22 p0255 A79-22522

Surtrace - An airborne geochemical system --- for earth surface micro-layer exploration  
22 p0255 A79-22557

Infrared remote sensing on geothermal areas by helicopter  
22 p0256 A79-22620

Mercury in some New Zealand geothermal discharges  
22 p0257 A79-22925

Mining earth's heat - Hot dry rock geothermal energy  
22 p0258 A79-23280

East Mesa geothermal test site  
22 p0259 A79-23458

A fundamental model for the evolution of a two-phase geothermal reservoir with application to environmental impact analysis  
22 p0263 A79-23777

Hot dry rock - A new potential for energy  
22 p0265 A79-23832

Geothermal energy in Imperial County, California - Environmental, socio-economic, demographic, and public opinion research conclusions and policy recommendations  
22 p0265 A79-24046

Continental geotherms during the Archean --- heat production in ancient earth crust  
22 p0269 A79-24620

Thermal conductivity of crystalline rocks associated with energy extraction for hot dry rock geothermal systems  
22 p0304 A79-30123

Direct heat applications of geothermal energy in the geysers/Clear Lake Region, volume 2: Environmental assessment  
[SAN-1326-1/2] 21 p0174 A79-10532

Geothermal Reservoir Engineering Management Program Plan (GREMP Plan)  
[LBL-7000] 21 p0174 A79-10536

National Geothermal Information Resource  
[LBL-7803] 21 p0187 A79-11515

Definition of engineering development and research problems relating to the use of geothermal fluids for electric power generation and nonelectric heating  
[LBL-7025] 21 p0188 A79-11534

Energy programs at The Johns Hopkins University Applied Physics Laboratory  
[PB-283171/7] 21 p0191 A79-11554

Potential producibility and recovery of natural gas from geopressed aquifers of the Cenozoic sediments of the Gulf Coast Basin  
[FE-2025-3] 21 p0192 A79-11607

Thermal stress cracking and the enhancement of heat extraction from fractured geothermal reservoirs  
[LA-7235-MS] 21 p0198 A79-12568

Evaluation and targeting of geothermal energy resources in the southeastern United States  
[VPI-SU-5648-1] 21 p0204 A79-13478

Geothermal emissions data base: Cerro Prieto geothermal field  
[UCID-4033] 21 p0204 A79-13480

Non-electric applications of geothermal energy in six Alaskan towns  
[IDO-1622-4] 21 p0208 A79-13523

OTEC thermal resource report for Central Gulf of Mexico  
[TID-27951] 21 p0209 A79-13533

Geothermal element, Imperial County, California  
[PB-287115/0] 22 p0335 A79-16385

Impact prediction manual for geothermal development  
[PB-288128/2] 22 p0349 A79-18462

Seismological investigations in geothermal regions  
22 p0356 A79-19506

Geothermal resources for aquaculture  
[PB-290345/8] 22 p0356 A79-19563

Toward assessing the geothermal potential of the Jemez Mountains volcanic complex: A telluric-magnetotelluric survey  
[LA-7656-MS] 22 p0358 A79-20458

Research on the physical properties of geothermal reservoir rock  
[COO-2908-4] 22 p0358 A79-20459

Methodology for modeling geothermal district heating for residential markets  
[BNL-50905] 22 p0361 A79-20502

A time domain survey of the Los Alamos Region, New Mexico  
[LA-7657-MS] 22 p0365 A79-21248

An assessment of subsurface salt water disposal experience on the Texas and Louisiana Gulf coast for application to disposal of salt water from geopressed geothermal wells  
[NVO/1531-2] 22 p0366 A79-21523

Microcrack technology for geothermal exploration and assessment  
[PB-290173/4] 22 p0367 A79-21530

A computerized reporting and monitoring system for geothermal energy development  
[LBL-8483] 22 p0369 A79-21555

Heat flow and radiogenic heat production in Brazil with implications for thermal evolution of continents  
22 p0373 A79-21689

**GERMANIUM**  
Black germanium solar selective absorber surfaces  
22 p0327 A79-31970

**GERMANIUM ALLOYS**  
Comprehensive thermoelectric properties of n- and p-type 78a/o Si - 22a/o Ge alloy  
22 p0259 A79-23604

**GERMANY**  
Dornier/RWE solar house in Essen, FRG  
22 p0276 A79-25933

Experience with the MBB-solar testing house at Otterfing and relevant consequences on the commercial product  
22 p0276 A79-25934

## SUBJECT INDEX

## HALIDES

- Application of LANDSAT data and digital image processing --- Ruhr Valley, Germany  
[E79-10102] 22 p0339 N79-17291
- GEYSERS**  
Direct heat applications of geothermal energy in the geysers/Clear Lake Region, volume 2: Environmental assessment  
[SAN/1326-1/2] 21 p0174 N79-10532
- GLACIERS**  
Power from glaciers - The hydropower potential of Greenland's glacial water 21 p0087 A79-15672
- GLASS**  
Requirements and new materials for fusion laser systems 21 p0082 A79-15138  
Review of theories for predicting n2 in glasses and crystals --- refractive index of fusion laser materials 21 p0083 A79-15139  
A survey of laser glasses --- for fusion studies 21 p0083 A79-15140  
Integral assembly of photovoltaic arrays using glass 22 p0241 A79-20883  
Structural cost optimization of photovoltaic central power station modules and support structure  
[ASHE PAPER 79-SOL-17] 22 p0309 A79-30551
- GLASS FIBER REINFORCED PLASTICS**  
Filon panels - A technical report --- fiberglass reinforced plastics for solar collectors 21 p0031 A79-10403  
Application of composite materials in the solar energy domain 21 p0034 A79-11195  
Rotating strength of glass-carbon fiber-reinforced hybrid composite discs 21 p0165 A79-20273  
Composite material flywheel for the electric-powered passenger vehicle 22 p0240 A79-20842  
A status of the 'Alpha-ply' composite flywheel concept development 22 p0241 A79-20843  
Comparative properties of fiber composites for energy-storage flywheels part A. Evaluation of fibers for flywheel rotors --- Kevlar/epoxy and glass/epoxy composites  
[UCRL-80116-PT-A] 21 p0215 N79-14165
- GLYCOLS**  
The anodic oxidation of ethyleneglycol at platinum, gold and Pt/Au-alloys in alkaline solution --- fuel cell electrocatalysis 21 p0037 A79-11795  
Recent advances in electrocatalysis and their implications for fuel cells 21 p0038 A79-11807
- GOLD**  
The dependence of optical properties on the structural composition of solar absorbers - Gold --- black 22 p0242 A79-21162
- GOLD COATINGS**  
Measuring the quasi-Fermi level and flat band potential of an illuminated Au/n-GaAs/.6/P/.4/ anode --- for solar cells 22 p0317 A79-31411
- GOVERNMENT PROCUREMENT**  
Venture analysis of a proposed federal photovoltaic eight-year procurement plan  
[ATAA PAPER 78-1766] 21 p0061 A79-13865  
Financial/management scenarios for a satellite power system program  
[AAS PAPER 78-144] 22 p0243 A79-21259
- GOVERNMENT/INDUSTRY RELATIONS**  
10-megawatt solar central receiver pilot plant 21 p0094 A79-15906  
An economist looks at solar energy - The government's role 21 p0099 A79-16132  
The need for closed service areas in a supply economy based on line networks --- for German gas and electric utilities 21 p0168 A79-20447  
Industrialization study --- impact of government incentives and barriers on decision making in the industrial production of photovoltaics  
[NASA-CR-157953] 21 p0200 N79-12970

## GOVERNMENTS

- Planning program to accelerate energy conservation in municipalities  
[HCE/M05017-01/1] 21 p0210 N79-13536  
Cooking with offshore oil: A handbook for California local government --- regional planning  
[PB-288656/2] 22 p0331 N79-16140
- GRAIN BOUNDARIES**  
Grain-boundary edge passivation of GaAs films by selective anodization --- shorting effect in solar cells 21 p0154 A79-18487  
Effect of grain boundaries in silicon on minority-carrier diffusion length and solar-cell efficiency 22 p0252 A79-21807
- GRAPHS (CHARTS)**  
A graphical approach to the efficiency of flat-plate collectors 21 p0102 A79-16422
- GRAVIMETRY**  
Combustion of droplets and sprays of some alternative fuels 21 p0052 A79-12983
- GRAVITY WAVES**  
A theory for wave-power absorption by two independently oscillating bodies 22 p0259 A79-23307
- GREAT PLAINS CORRIDOR (NORTH AMERICA)**  
The ground water and energy supply situation for Great Plains irrigation  
[PB-286002/1] 21 p0222 N79-14586
- GREENHOUSE EFFECT**  
An earth-wrapped solar greenhouse house --- partially buried structure 21 p0140 A79-17493
- GROUND EFFECT**  
Energy effectiveness of arbitrary arrays of wind turbines  
[ATAA PAPER 79-0114] 21 p0156 A79-19540
- GROUND TRUTH**  
Remote monitoring of coal strip mine rehabilitation  
[PB-286647/3] 21 p0228 N79-15379  
Late diagenetic indicators of buried oil and gas. 2: Direct detection experiment at Cement and Garza fields, Oklahoma and Texas, using enhanced LANDSAT 1 and 2 images  
[E79-10099] 22 p0347 N79-18373
- GROUND WATER**  
The ground water and energy supply situation for Great Plains irrigation  
[PB-286002/1] 21 p0222 N79-14586
- GROUND WIND**  
Run duration analysis of surface wind speeds for wind energy application 22 p0287 A79-27345
- GROUP 6A COMPOUNDS**  
Photovoltaic effects in II-VI heterojunctions 21 p0042 A79-11967
- GULF OF MEXICO**  
Potential producibility and recovery of natural gas from geopressed aquifers of the Cenozoic sediments of the Gulf Coast Basin  
[PE-2025-3] 21 p0192 N79-11607  
OTEC thermal resource report for Central Gulf of Mexico  
[TID-27951] 21 p0209 N79-13533  
An assessment of subsurface salt water disposal experience on the Texas and Louisiana Gulf coast for application to disposal of salt water from geopressed geothermal wells  
[NVC/1531-2] 22 p0366 N79-21523
- GULFS**  
A numerical model investigation of tidal phenomena in the Bay of Fundy and Gulf of Maine 22 p0323 A79-31554

## H

- HAIL**  
Hail risk model for solar collectors 21 p0098 A79-16103  
Simulated hail impact testing of photovoltaic solar panels 21 p0098 A79-16116
- HALIDES**  
A study of positive electrode materials for batteries operating in a halide-aluminate medium 22 p0245 A79-21480

# HALL EFFECT

# SUBJECT INDEX

## HALL EFFECT

- The ion fly-wheel effect on the electro-thermal instability in non-equilibrium MHD Hall disc generators 21 p0046 A79-12270
- Effect of finite boundary layer on the ionization instability in non-equilibrium MHD generators 21 p0153 A79-18469
- The electric conductivity of a plasma of combustion products of hydrocarbon fuels with alkali impurity 21 p0167 A79-20415
- Investigation of the Hall effect in a discharge with a rotational electric field 22 p0246 A79-21532

## HALLEY'S COMET

- Ultralow-mass solar-array designs for Halley's comet rendezvous mission 21 p0020 A79-10169

## HALOGENS

- Thermodynamic and kinetic considerations on zinc-halogen batteries 21 p0040 A79-11822

## HANDBOOKS

- Engineering handbook on the atmospheric environmental guidelines for use in wind turbine generator development [NASA-TP-1359] 21 p0223 N79-14679

## HARDWARE UTILIZATION LISTS

- Solar energy in developing countries: An overview and buyers' guide for solar scientists and engineers --- Book 22 p0327 A79-32139

## HARMONIC GENERATIONS

- Generation of the new coherent radiation by harmonic conversion and nonlinear mixing for certain applications --- optical interactions 21 p0111 A79-16639

## HAWAII

- Oahu wind power survey [PB-287361/0] 22 p0335 N79-16382

## HEALTH PHYSICS

- Status of bioscreening of emissions and effluents from energy technologies 22 p0346 N79-18353

## HEAT BALANCE

- Quasi-equilibrium Air Standard heat balanced cycle analysis 21 p0028 A79-10232
- On the ion energy balance in TFR with and without neutral injection heating 21 p0069 A79-14452
- Review of results from DITE tokamak 21 p0069 A79-14456

## HEAT EXCHANGERS

- Heat exchanger designs for coal-fired fluidized beds 21 p0009 A79-10079
- Analysis and application of the heat pipe heat exchanger 21 p0014 A79-10117
- Geothermal power from salt domes 21 p0014 A79-10120
- Thermionic power plant design point selection - The economic impact 21 p0025 A79-10214
- Thermal energy storage heat exchanger design [ASME PAPER 78-ENAS-30] 21 p0049 A79-12579
- Ceramic heat exchanger - Applications and developments 21 p0050 A79-12826
- OTEC program status and plans 21 p0094 A79-15902
- OTEC power systems 21 p0101 A79-16248
- The El Camino Real Solar Cooling Demonstration Project 21 p0102 A79-16425
- Energy storage for tokamak reactor cycles --- during downtime for periodic plasma quench and reignition 21 p0111 A79-16727
- Study of a heat exchanger with heat pipes within the system of a small-scale gas-turbine engine 21 p0114 A79-16800
- Performance studies of a finned heat pipe latent thermal energy storage system 21 p0121 A79-17325
- A heat pipe collector for low temperatures 21 p0127 A79-17385

Thermosyphon models for downhole heat exchanger applications in shallow geothermal systems 21 p0150 A79-18092

Slag transport models for radiant heater of an MHD system [ASME PAPER 78-WA/HT-21] 21 p0161 A79-19808

Conceptual design of large heat exchangers for ocean thermal energy conversion [ASME PAPER 78-WA/HT-32] 21 p0161 A79-19813

Development of compact heat exchangers for Ocean Thermal Energy Conversion /OTEC/ systems [ASME PAPER 78-WA/HT-34] 21 p0161 A79-19815

The analysis of heat transfer with and without condensation in a heat pipe heat exchanger [ASME PAPER 78-WA/HT-59] 21 p0161 A79-19824

The use of heat exchangers with THERMOEXCEL's tubing in ocean thermal energy power plants [ASME PAPER 78-WA/HT-65] 21 p0162 A79-19825

A ceramic heat exchanger for a Brayton cycle solar electric power plant 22 p0239 A79-20822

Design and optimisation of an absorption refrigeration system operated by solar energy 22 p0285 A79-26819

Measured effects of flow leakage on the performance of the GT-225 automotive gas turbine engine [ASME PAPER 79-GT-3] 22 p0306 A79-30502

Control system for solar hot water system 22 p0321 A79-31442

Prototype solar-heated hot water systems and double-walled heat exchangers [NASA-CR-150854] 21 p0205 N79-13495

Silicon sheet growth development for the large area sheet task of the low cost solar array project. Heat exchanger method - ingot casting fixed abrasive method - multi-wire slicing [NASA-CR-158038] 21 p0219 N79-14540

State-of-the-art study of heat exchangers used with solar assisted domestic hot water systems (potential contamination of potable water supply) [PB-287410/5] 22 p0343 N79-17351

Thermal energy transformer [NASA-CASE-NPO-14058-1] 22 p0348 N79-18443

Development of a phase-change thermal storage system using modified anhydrous sodium hydroxide for solar electric power generation. [NASA-CR-159465] 22 p0354 N79-19454

An improved solar energy receiver for a stirling engine [NASA-CASE-NPO-14619-1] 22 p0362 N79-20513

Active heat exchange system development for latent heat thermal energy storage [NASA-CR-159479] 22 p0368 N79-21554

Liquid-fluidized-bed heat exchanger flow distribution models [ICP-1151] 22 p0369 N79-21559

## HEAT FLUX

Reduction of the heat loss flux of collectors by infrared reflecting coatings on cover plates 21 p0058 A79-13649

Periodic heating/cooling by solar radiation --- through concrete slab buildings 21 p0140 A79-17491

## HEAT GENERATION

Development and application of techniques to evaluate cogeneration impacts --- simultaneous electric energy and process heat production in electric power plants 22 p0303 A79-29795

## HEAT MEASUREMENT

Measurement of heat loss from a heat receiver assembly of a Fixed Mirror Solar Concentrator 21 p0020 A79-10166

The application of thermography to large arrays of solar energy collectors 22 p0242 A79-21171

Differential scanning calorimetry studies of possible explosion-causing mixtures in Li/SO2 cells 22 p0246 A79-21487

Test procedures for the determination of the gross caloric value of refuse and refuse-derived-fuels by oxygen bomb calorimetry: Summary of the 1977 fiscal year results [PB-290160/1] 22 p0364 N79-21167

# SUBJECT INDEX

# HEAT SOURCES

## HEAT OF FORMATION

- Calculated heats of formation of metal and metal alloy hydrides 22 p0249 A79-21690
- Hydrides of rare earth-nickel compounds - Structure and formation enthalpies 22 p0250 A79-21697

## HEAT PIPES

- Lithium and potassium heat pipes for thermionic converters 21 p0013 A79-10113
- Liquid metal heat pipes for the central solar receiver 21 p0014 A79-10114
- Cost effective solar collectors using heat pipes 21 p0014 A79-10115
- Analysis and application of the heat pipe heat exchanger 21 p0014 A79-10117
- Heat pipe central solar receiver gas turbine plant 21 p0022 A79-10178
- Copper/water axially-grooved heat pipes for RTG applications 21 p0023 A79-10188
- Liquid metal heat pipe performance in the presence of a transverse magnetic field --- for fusion reactors [ASME PAPER 78-ENAS-20] 21 p0048 A79-12569
- Study of a heat exchanger with heat pipes within the system of a small-scale gas-turbine engine 21 p0114 A79-16800
- Performance studies of a finned heat pipe latent thermal energy storage system 21 p0121 A79-17325
- A heat pipe collector for low temperatures 21 p0127 A79-17385
- The analysis of heat transfer with and without condensation in a heat pipe heat exchanger [ASME PAPER 78-WA/HT-59] 21 p0161 A79-19824
- Experimental study of the characteristics of heat and mass transfer in a two-component low-temperature heat pipe 22 p0246 A79-21585
- Design of a heat pipe with separate channels for vapor and liquid 22 p0268 A79-24486
- Investigation of the thermophysical characteristics of cryogenic heat pipes with a metal-fiber wick 22 p0288 A79-27529
- Transient shutdown analysis of low-temperature thermal diodes [NASA-TF-1369] 22 p0346 A79-18287

## HEAT PUMPS

- Performance of a Stirling engine powered heat activated heat pump --- gas heating-cooling system 21 p0011 A79-10098
- A thermochemical energy storage system and heat pump 21 p0012 A79-10105
- Analysis and design of an 18-ton solar-powered heating and cooling system 21 p0019 A79-10156
- The matching of a free piston Stirling engine coupled with a free piston linear compressor for a heat pump application 21 p0024 A79-10204
- A Stirling engine heat pump system 21 p0024 A79-10206
- Metal hydride solar heat pump and power system /HYCSOS/ [AIAA PAPER 78-1762] 21 p0061 A79-13863
- Heat pumps without supplemental heat 21 p0073 A79-14695
- Theory of solar assisted heat pumps 21 p0090 A79-15864
- Controls for heat reclaim with thermal storage coupled with solar heating 21 p0102 A79-16420
- Solar pumping --- thermal and electrical water pumping 21 p0104 A79-16469
- A solar energy system with a dual-source heat pump and long-term storage 21 p0119 A79-17312
- Chemically driven heat pumps for solar thermal storage 21 p0120 A79-17316

Design problems of air source solar boosted heat pumps

- 21 p0138 A79-17472
  - Limitations of solar assisted heat pump systems [ASME PAPER 78-WA/SOL-1] 21 p0162 A79-19834
  - Efficiency improvement by means of multicomponent processes - Improvement of the efficiency of heat-power transformation by means of an employment of Clausius-Rankine sorption processes 21 p0164 A79-19975
  - Some applications of LaNi5-type hydrides --- using reversible reaction with hydrogen working fluid for heat storage 22 p0249 A79-21694
  - HYCSOS - A system for evaluation of hydrides as chemical heat pumps 22 p0252 A79-21716
  - Solar heating using a heat pump and cold collectors 22 p0254 A79-22268
  - Estimating heat loads on multistage thermoelectric heat pumps 22 p0260 A79-23614
  - Stability of work and sensitivity of semiconductor thermoelectric systems under automatic control 22 p0261 A79-23624
  - Sulfuric acid-water - Chemical heat pump/energy storage system demonstration 22 p0281 A79-26209
  - Performance of combined solar-heat pump systems 22 p0285 A79-26817
  - Heat pump technology for saving energy --- Book 22 p0302 A79-29624
  - Regulation and control concepts for the possibilities of a utilization of solar energy in the low-temperature range 22 p0305 A79-30345
  - Review of liquid piston pumps and their operation with solar energy [ASME PAPER 79-SOL-4] 22 p0308 A79-30542
  - Heat pump design - Cost effectiveness in the collection, storage and distribution of solar energy 22 p0313 A79-31316
  - WATSUN - A simulation program for solar-assisted heating systems 22 p0321 A79-31439
  - Solar assisted heat pump study for heating of military facilities [AD-A058626] 21 p0206 A79-13506
  - Heat pump technology: A survey of technical developments, market prospects and research needs [HCP/M2121-01] 21 p0210 A79-13540
  - Energy and economic analysis of industrial process heat recovery with heat pumps 22 p0331 A79-16210
  - Development of thermal prime movers for heat pump drive 22 p0332 A79-16263
  - Parameter estimation and validation of a solar assisted heat pump model 22 p0332 A79-16349
  - Certification report for the CALMAC solar powered pump [NASA-CR-150872] 22 p0341 A79-17331
  - Development, testing, and certification of Calmac Mfg. Corp. solar collector and solar operated pump [NASA-TN-78218] 22 p0342 A79-17338
- ## HEAT RADIATORS
- Ultralightweight structures for space power --- solar energy collection for transmission to earth 21 p0108 A79-16609
  - An analytical investigation of the performance of solar collectors as nighttime heat radiators in airconditioning cycles [NASA-CR-3111] 22 p0363 A79-20519
- ## HEAT RESISTANT ALLOYS
- State of the art and science report on design of alloys resistant to high-temperature corrosion-erosion in coal conversion environments [EPRI-FP-557] 21 p0200 A79-13149
- ## HEAT SINKS
- The use of liquid natural gas as heat sink for power cycles 22 p0332 A79-16262
- ## HEAT SOURCES
- Energy distribution and storage alternates with a centralized heat source 21 p0013 A79-10112

## HEAT STORAGE

## SUBJECT INDEX

Selenide isotope generator for the Galileo mission  
21 p0022 A79-10185

Shallow magmatic reservoirs as heat source of  
geothermal systems - Preliminary interpretation  
of data available for the Neapolitan active  
volcanic areas  
21 p0075 A79-14727

Industrial cogeneration - Problems and promise ---  
waste heat utilization from electricity production  
22 p0265 A79-24047

The potential of fusion reactors as process heat  
source  
22 p0284 A79-26624

Alternative power-generation systems  
21 p0169 N79-10129

Renewable ocean energy sources. Part 1: Ocean  
thermal energy conversion.  
[PB-283104/8]  
21 p0191 N79-11556

Renewable ocean energy sources. Part 1: Working  
papers. Ocean thermal energy conversion  
[PB-283103/0]  
21 p0191 N79-11557

Utilization of waste heat in trucks for increased  
fuel economy  
[NASA-TN-79966]  
21 p0215 N79-13937

Environmental and radiological safety studies.  
Interaction of (Pu-238)O<sub>2</sub> heat sources with  
terrestrial and aquatic environments --- soil  
and water analysis  
[LA-7033-PR]  
21 p0232 N79-15783

Development of thermal prime movers for heat pump  
drive  
22 p0332 N79-16263

Power cycles and working fluids for low  
temperature heat sources  
22 p0332 N79-16268

### HEAT STORAGE

Thermal energy storage for industrial waste heat  
recovery  
21 p0012 A79-10101

High efficiency thermal energy storage system for  
utility applications  
21 p0012 A79-10102

High temperature thermal energy storage in moving  
sand  
21 p0012 A79-10103

NaOH-based high temperature heat-of-fusion thermal  
energy storage device  
21 p0012 A79-10106

Form-stable, crystalline polymer pellets for  
thermal energy storage  
21 p0013 A79-10107

Storage systems for solar thermal  
power  
21 p0013 A79-10108

Hybrid air to water solar collector design  
21 p0021 A79-10174

Central solar heat stations and the Studsvik  
Demonstration Plant  
21 p0021 A79-10175

Basic physical and chemical processes for storage  
of heat  
21 p0038 A79-11805

Solar thermal energy storage using heat of  
dilution - Analysis of heat generation in  
multistage mixing column  
21 p0046 A79-12271

Thermal energy storage heat exchanger design  
[ASME PAPER 78-ENAS-30]  
21 p0049 A79-12579

The economic performance of passive solar heating  
- A preliminary analysis --- thermal storage  
wall for family home design  
[AIAA PAPER 78-1761]  
21 p0061 A79-13862

Economic optimization of heatpump assisted solar  
heating in Illinois  
21 p0072 A79-14691

Heat pumps without supplemental heat  
21 p0073 A79-14695

Boosting the performance of solar HVAC systems by  
improving component interactions --- Heating,  
Ventilating and Air Conditioning  
21 p0089 A79-15851

Passive solar heating of buildings  
[LA-UR-77-1162]  
21 p0090 A79-15859

Residential and commercial thermal storage --- for  
solar heating and cooling systems  
21 p0090 A79-15865

Large-scale thermal energy storage for  
cogeneration and solar systems --- in aquifers  
21 p0092 A79-15886

Controls for heat reclaim with thermal storage  
coupled with solar heating  
21 p0102 A79-16420

Thermal storage of solar energy  
21 p0103 A79-16459

Quasi-isentropic laser engines  
21 p0111 A79-16632

A solar energy system with a dual-source heat pump  
and long-term storage  
21 p0119 A79-17312

Long-term thermal storage in solar architecture in  
northern latitudes, with reference to typical  
single family dwellings  
21 p0119 A79-17313

Long-term storage of solar energy in native rock  
21 p0120 A79-17314

Chemically driven heat pumps for solar thermal  
storage  
21 p0120 A79-17316

Underground aquifer storage of hot water from  
solar energy collectors  
21 p0120 A79-17317

A simulation study of phase change energy store  
21 p0120 A79-17318

Investigation of physical and chemical properties  
of phase change materials for space  
heating/cooling applications  
21 p0120 A79-17319

Phase change thermal storage for a solar total  
energy system  
21 p0120 A79-17321

A passive integrated unit for the collection,  
thermal storage in fusion materials and  
distribution of solar energy for home heating  
and other applications  
21 p0121 A79-17322

Theoretical and experimental analysis of a latent  
heat storage system --- solar energy absorbers  
21 p0121 A79-17323

A thermal storage analysis on packed bed of  
alumina spheres --- in solar houses  
21 p0121 A79-17324

Performance studies of a finned heat pipe latent  
thermal energy storage system  
21 p0121 A79-17325

Stratification effects in the short and long term  
storage of solar heat  
21 p0121 A79-17326

Use of monolithic structures for the short term  
storage of solar energy  
21 p0121 A79-17327

A passive rock bed - Design, construction, and  
performance  
21 p0121 A79-17328

Investigation on the feasibility of using a  
two-phase thermosyphon for solar storage, space  
heating and cooking  
21 p0121 A79-17330

A study for optimum use of metallic plates for  
thermal storage in solar processes  
21 p0122 A79-17331

Analysis of thermal storage unit for solar energy  
21 p0122 A79-17332

An analytical and experimental study of pumped  
solar water heaters  
21 p0128 A79-17389

Annual collection and storage of solar energy for  
the heating of buildings  
21 p0131 A79-17415

A report on the various heat collection and heat  
storage systems evolved under the solar energy  
programme at B. I. T. S.  
21 p0132 A79-17423

Two thermodynamic optima in the design of sensible  
heat units for energy storage  
21 p0150 A79-18091

A theoretical analysis of solar collector/storage  
panels  
[ASME PAPER 78-WA/SOL-11]  
21 p0163 A79-19843

Solar collector storage panel  
[ASME PAPER 78-WA/SOL-12]  
21 p0163 A79-19844

On the optimisation of Trombe wall solar collectors  
[ASME PAPER 78-WA/SOL-13]  
21 p0163 A79-19845

Energy storage using the reversible oxidation of  
barium oxide  
22 p0242 A79-21169

Thermal storage for industrial process and reject  
heat  
22 p0243 A79-21300



# SUBJECT INDEX

# HEAT TRANSFER COEFFICIENTS

- Some applications of LaNi5-type hydrides --- using reversible reaction with hydrogen working fluid for heat storage 22 p0249 A79-21694
- Storage efficiency in a solar plant 22 p0254 A79-22270
- Prediction of the behavior of a solar storage system by means of recurrent stochastic models --- of insolation 22 p0258 A79-23295
- Prediction of the performance of solar heating systems utilizing annual storage 22 p0263 A79-23760
- Effects of low solar input and amount of storage on thermosyphon hot water system performance 22 p0267 A79-24312
- Solar storage unit with built-in oil-gas boiler 22 p0268 A79-24322
- Thermal storage and heat transfer in solar energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978 22 p0280 A79-26201
- Analysis of energy storage by phase change with an array of cylindrical tubes 22 p0281 A79-26207
- Earth-conducted heat losses from thermal storage systems 22 p0281 A79-26208
- Sulfuric acid-water - Chemical heat pump/energy storage system demonstration 22 p0281 A79-26209
- Heat transfer and calorimetric studies of a direct contact-latent heat energy storage system 22 p0281 A79-26210
- Thermal energy storage 22 p0310 A79-31000
- Studies on the effect of bed aspect ratios and pressure drop on flow distribution in rock bed storage systems for solar energy applications 22 p0317 A79-31409
- Distributed energy storage for solar applications 22 p0317 A79-31410
- Collector and storage efficiencies in solar heating systems 22 p0320 A79-31432
- Measured and modeled passive performance in Montana --- for solar heating and thermal storage 22 p0322 A79-31445
- Integration of a passive and active solar heated, low density, multiple dwelling with atrium 22 p0322 A79-31446
- Sensible heat storage for solar energy applications 22 p0322 A79-31449
- Alternate energy installations on the Jordan College Campus 22 p0323 A79-31454
- Solar heating of domestic hot water at the Confederation Heights Cafeteria 22 p0323 A79-31457
- Thermal performance evaluation of the Calmac (liquid) solar collector [NASA-CR-150819] 21 p0173 N79-10521
- Feasibility study of transporting offshore OTEC-produced energy to shore by thermal media. Project 8980 [DSE/2426-19] 21 p0174 N79-10535
- Thermal storage for industrial process and reject heat [NASA-TM-78994] 21 p0183 N79-11481
- Conceptual design of thermal energy storage systems for near term electric utility applications. Volume 1: Screening of concepts [NASA-CR-159411-VOL-1] 21 p0205 N79-13496
- The role of thermal energy storage in industrial energy conservation [NASA-TM-79122] 22 p0368 N79-21550
- Active heat exchange system development for latent heat thermal energy storage [NASA-CR-159479] 22 p0368 N79-21554
- HEAT TRANSFER**
- Circulating-bed boiler concepts for steam and power generation 21 p0008 A79-10071
- Transient energy removal in cylindrical parabolic collector systems 21 p0020 A79-10168
- Influence of cyclic wall-to-gas heat transfer in the cylinder of the valved hot-gas engine 21 p0024 A79-10201
- Collisional transport --- particle diffusion and heat transport in tokamak 21 p0078 A79-14780
- Effect of buoyancy and tube inclination on heat transfer in a solar air heater 21 p0129 A79-17402
- Heat transfer analysis of flat plate type domestic solar water heater 21 p0140 A79-17489
- Heat transfer - A review of 1977 literature 21 p0155 A79-18973
- The role of interfacial heat and mechanical energy transfers in a liquid-metal MHD generator [ASME PAPER 78-WA/HT-33] 21 p0161 A79-19814
- The analysis of heat transfer with and without condensation in a heat pipe heat exchanger [ASME PAPER 78-WA/HT-59] 21 p0161 A79-19824
- Experimental study of the characteristics of heat and mass transfer in a two-component low-temperature heat pipe 22 p0246 A79-21585
- Collisional transport --- of plasmas in plane and toroidal geometry 22 p0257 A79-22980
- Design of a heat pipe with separate channels for vapor and liquid 22 p0268 A79-24486
- Quasi-linear theory of heat flow and diffusion in a tokamak 22 p0270 A79-24859
- Radiant exchange for a fin and tube solar collector 22 p0271 A79-25066
- Thermal storage and heat transfer in solar energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978 22 p0280 A79-26201
- Heat transfer in a solar radiation absorbing fluid layer flowing over a substrate 22 p0281 A79-26204
- Heat transfer and calorimetric studies of a direct contact-latent heat energy storage system 22 p0281 A79-26210
- Investigation of the heat transfer in cylindrical receiver configurations with inner tubes [ASME PAPER 79-GT-64] 22 p0306 A79-30532
- Heat transport near the wall of a tokamak reactor 22 p0324 A79-31764
- Some heat transfer and hydrodynamic problems associated with superconducting cables (SPTL) [NASA-TM-79023] 21 p0226 N79-15267
- Environmental and safety considerations for solar heating and cooling applications [PB-287772/8] 22 p0343 N79-17350
- Thermal performance evaluation of MSFC hot air collectors with various flow channel depth [NASA-CR-150900] 22 p0348 N79-18449
- MHD balance of plant technology project [ANL-MHD-78-7] 22 p0361 N79-20500
- HEAT TRANSFER COEFFICIENTS**
- A simulation study of phase change energy store 21 p0120 A79-17318
- A thermal storage analysis on packed bed of alumina spheres --- in solar houses 21 p0121 A79-17324
- An interferometric investigation heat transfer in honeycomb solar collector cells 21 p0129 A79-17398
- The use of heat exchangers with THERMOEXCEL's tubing in ocean thermal energy power plants [ASME PAPER 78-WA/HT-65] 21 p0162 A79-19825
- Determination of thermal contact resistances --- for solar thermoelectric generators 21 p0166 A79-20351
- Comparison of transient heat transfer models for flat plate collectors 22 p0242 A79-21168
- Heat transfer characteristics of porous metallic matrix metal-hydrides 22 p0251 A79-21706
- Some effects of leg surface heat losses on the performance of a p-n type thermoelectric generator 22 p0260 A79-23616

# HEAT TRANSMISSION

# SUBJECT INDEX

Investigation of the thermophysical characteristics of cryogenic heat pipes with a metal-fiber wick 21 p0288 A79-27529

Coal liquefaction support studies. Task 1: Heat of reaction of hydrogen with coal slurries. Task 2: Heat transfer coefficient [ANL/CEN/PE-77-5] 21 p0216 N79-14242

**HEAT TRANSMISSION**

Regional air pollution study: Heat emission inventory [PB-284081/7] 21 p0200 N79-12602

Heat flow and radiogenic heat production in Brazil with implications for thermal evolution of continents 22 p0373 N79-21689

**HEATERS**

Progress in the testing of materials and design concepts for directly-fired MHD air heater service 21 p0017 A79-10141

Production and application of rolling-welded aluminum alloy panels for solar water heaters for hot water and cooling systems 22 p0297 A79-28670

Study of the temperature distribution across the width of the screen of low-temperature water heaters with tubular heat receivers 22 p0297 A79-28671

**HEATING**

Geothermal preheating in fossil-fired steam power plants 21 p0014 A79-10118

Oil shale retorting - A correlation of selected infrared absorbance bands with process heating rates and oil yield 22 p0304 A79-29975

Geographical variation in the heating and cooling requirements of a typical single-family house, and correlation of these requirements to degree days [PB-289204/0] 22 p0355 N79-19467

Geothermal resources for aquaculture [PB-290345/8] 22 p0356 N79-19563

Methodology for modeling geothermal district heating for residential markets [ANL-50905] 22 p0361 N79-20502

**HEATING EQUIPMENT**

Technical analysis for cogeneration systems with potential applications in twelve California industrial plants --- energy saving heat-electricity utility systems 21 p0011 A79-10099

A thermodynamic study of heating with geothermal energy. [ASME PAPER 77-WA/ENER-1] 21 p0030 A79-10253

Return flow solar air-heater 21 p0055 A79-13609

Control of solar energy systems, heat storage, and heat utilization 21 p0056 A79-13630

Simple high-accuracy diode temperature-difference control circuit 21 p0056 A79-13631

The Arbonia control concept - Does flow regulation in the solar system cycle make sense --- working fluid regulation in solar heating facility 21 p0056 A79-13632

Solar heating and safety techniques 21 p0056 A79-13633

Safety requirements for solar heating systems - Practical considerations 21 p0056 A79-13634

Design of a low-energy house in Denmark heated by a combination of solar and wind energy 21 p0058 A79-13652

Design of a direct wind energy converter to heat water by agitation in a closed tank 21 p0067 A79-14290

Alternative energy for domestic hot water - Wind or solar 21 p0067 A79-14292

Economic optimization of heatpump assisted solar heating in Illinois 21 p0072 A79-14691

Heat recovery devices for building HVAC systems --- Heating Ventilating and Air Conditioning 21 p0073 A79-14697

Investigation of the optimal use of geothermal waters for the heating of several types of dwelling in various European climates 21 p0075 A79-14739

Preliminary results of the new geothermal domestic heating system at Creil 21 p0075 A79-14740

Conference on Performance Monitoring Techniques for Evaluation of Solar Heating and Cooling Systems, Washington, D.C., April 3, 4, 1978, Proceedings 21 p0087 A79-15826

Acceleration of solar heating application via improved data evaluation 21 p0087 A79-15829

System performance measurements for a packaged solar space heating system equipped with air-heating collectors 21 p0088 A79-15835

Materials problems and opportunities in coal conversion systems 21 p0094 A79-15900

Inexpensive solar energy utilization in human settlements 21 p0104 A79-16470

High-temperature oxidizer preheater --- for fossil fuel MHD energy conversion 21 p0106 A79-16487

The status of solar energy --- for domestic water heating and thermal electric power generation 21 p0115 A79-17219

Economic evaluation and optimization of solar heating systems 21 p0118 A79-17293

A solar energy system with a dual-source heat pump and long-term storage 21 p0119 A79-17312

Cheap packed bed absorbers for solar air heaters 21 p0128 A79-17388

An analytical and experimental study of pumped solar water heaters 21 p0128 A79-17389

Effect of buoyancy and tube inclination on heat transfer in a solar air heater 21 p0129 A79-17402

Space heating with solar all-air systems - CSU Solar House II 21 p0137 A79-17467

The interface with solar - Alternative auxiliary supply systems --- for solar space heating 21 p0137 A79-17468

Design problems of air source solar boosted heat pumps 21 p0138 A79-17472

Heattube, a universal electrical solar heat equipment for building, community and agricultural purposes 21 p0138 A79-17473

Properties optimization for phase-change energy storage in air-based solar heating systems 21 p0149 A79-18018

Experimental measurements and correlations of Nusselt number for MHD high temperature air preheaters [ASME PAPER 78-WA/HT-22] 21 p0161 A79-19809

Structural design of a superheater for a central solar receiver [ASME PAPER 78-WA/PVP-1] 21 p0162 A79-19832

Performance evaluation of the New Mexico State University Solar House [ASME PAPER 78-WA/SOL-8] 21 p0163 A79-19840

Heat pump technology for saving energy --- Book 22 p0302 A79-29624

Report on a survey of operational solar systems 22 p0318 A79-31418

NRC solar monitoring program 22 p0318 A79-31419

Measured and predicted performance of solar domestic water heaters 22 p0319 A79-31422

Allowable costs for alternative domestic heating systems using utility supplied electricity for backup or charging energy 22 p0319 A79-31428

Component cost of solar energy systems 22 p0319 A79-31429

Preliminary design package for solar heating and hot water system [NASA-CR-150619] 21 p0173 N79-10520

## SUBJECT INDEX

## HIGH FIELD MAGNETS

- Elemental characteristics of aerosols emitted from a coal-fired heating plant  
[NASA-TN-78749] 21 p0191 N79-11560
- SIMS prototype system 4 - performance test report  
[NASA-CR-150820] 21 p0205 N79-13499
- Fluidized bed gas turbine experimental unit for MIOS applications  
[ORNL/HDS/MIOS-33] 21 p0221 N79-14575
- System design package for SIMS prototype system 3, solar heating and domestic hot water  
[NASA-CR-150840] 22 p0333 N79-16359
- Phase one/base data for the development of energy performance standards for new buildings. Climatic classification  
[PE-286900/6] 22 p0336 N79-16497
- Verification test report on a solar heating and hot water system  
[NASA-CR-161165] 22 p0360 N79-20493
- HEAVY IONS**
- Heavy-ion beam inertial-confinement fusion  
21 p0054 A79-13448
- HEAVY LIFT LAUNCH VEHICLES**
- Satellite Power Systems (SPS) concept definition study. Volume 5: Transportation and operations analysis --- heavy lift launch and orbit transfer vehicles for orbital assembly  
[NASA-CR-158067] 21 p0225 N79-15139
- Satellite power system: Concept development and evaluation program, reference system report  
[NASA-TN-80413] 22 p0367 N79-21538
- HELICAL INDUCERS**
- Preliminary design of a subscale ceramic helical-rotor expander  
21 p0050 A79-12849
- HELICAL WINDINGS**
- Heating and confinement in the CLEO stellarator  
21 p0070 A79-14459
- HELICOPTER ENGINES**
- Modern engine development test techniques --- for helicopters  
21 p0155 A79-18680
- Technology evolution in the Allison Model 250 engine --- for helicopter propulsion  
21 p0155 A79-18681
- HELICOPTER PERFORMANCE**
- Infrared remote sensing on geothermal areas by helicopter  
22 p0256 A79-22620
- HELIOSTATS**
- Specular mirrors for solar energy application  
21 p0034 A79-11147
- Five MW solar thermal test facility heliostat focus and alignment system  
21 p0043 A79-11972
- Predicted performance of heliostats for ERDA's 10 MWe power plant  
21 p0044 A79-12045
- Solar power plants in the U.S.A.  
21 p0057 A79-13640
- Flexed beams in central receiver heliostat drives  
[AIAA PAPER 78-1755] 21 p0060 A79-13856
- Results of a tilt-tilt low profile heliostat test program  
21 p0076 A79-14761
- Net energy analysis and environmental aspects for solar tower central receiver systems. I - Methodology  
21 p0097 A79-16101
- A status report on the Solar Thermal Test Facility  
21 p0112 A79-16731
- Design fabrication and testing of three meter diameter parabolic dish heliostat system  
21 p0135 A79-17447
- The design and evaluation of a hydraulic-solar powered tracking device  
21 p0136 A79-17458
- Efficiency degradation due to tracking errors for point focusing solar collectors  
[ASME PAPER 78-WA/SOL-4] 21 p0162 A79-19837
- 1MW calorimetric receiver for Solar Thermal Test Facility  
[ASME PAPER 78-WA/SOL-7] 21 p0163 A79-19839
- Composite heliostats of large solar plants  
21 p0166 A79-20350
- Analysis and design of a field of heliostats for a solar power plant  
22 p0242 A79-21161
- Optical analysis of solar facility heliostats  
22 p0296 A79-28360
- Design considerations of small solar collector systems using plane heliostats  
[ASME PAPER 79-SOL-2] 22 p0307 A79-30540
- HELIUM**
- Some heat transfer and hydrodynamic problems associated with superconducting cables (SPTL)  
[NASA-TN-79023] 21 p0226 N79-15267
- HELIUM-BRON LASERS**
- Verification of wedge concentration using a helium neon laser --- solar collector design  
21 p0098 A79-16104
- HETEROJUNCTION DEVICES**
- Recent progress in thin film polycrystalline solar cells based on cadmium sulfide  
21 p0042 A79-11966
- Photovoltaic effects in II-VI heterojunctions  
21 p0042 A79-11967
- High efficiency solar cells based on indium phosphide  
21 p0042 A79-11968
- The photovoltaic effect in CdS/Cu<sub>2</sub>S solar cells  
21 p0091 A79-15871
- Sprayed CdS thin films for CdS/Cu<sub>2</sub>S heterojunction solar cells  
21 p0123 A79-17386
- A high-efficiency GaAlAs double-heterostructure photovoltaic detector --- with antireflection coating  
21 p0154 A79-18489
- Photoelectric properties of pCdTe-nCdS film heterojunctions  
21 p0166 A79-20347
- Calculating the photocurrent and maximum efficiency of film p-CdTe-n-CdS photocells  
21 p0166 A79-20354
- High-efficiency AlGaAs/GaAs concentrator solar cells  
22 p0261 A79-23710
- Angle-of-incidence effects in electron-beam-deposited SnO<sub>2</sub>/Si solar cells  
22 p0272 A79-25069
- Series resistance effects in GaAl/As/GaAs concentrator solar cells  
22 p0273 A79-25745
- Ga<sub>1-x</sub>Al<sub>x</sub>/As-GaAs photovoltaic cells with multilayer structure --- heterostructure solar cell fabrication  
22 p0305 A79-30258
- Material growth and characterization directed toward improving III-V heterojunction solar cells  
[NASA-CR-158476] 22 p0367 N79-21543
- HEXAGONS**
- Comparison of the solar concentrating properties of truncated hexagonal, pyramidal and circular cones  
21 p0043 A79-11974
- HIGH ALTITUDE**
- NACA research on hydrogen for high altitude aircraft  
22 p0338 A79-16999
- New initiatives in high altitude aircraft  
22 p0338 A79-17000
- HIGH ASPECT RATIO**
- Characterization of electron and ion current flow in very large aspect-ratio terawatt diodes employing heated and unheated anodes  
21 p0154 A79-18480
- HIGH CURRENT**
- Superconducting magnets --- for MHD applications  
21 p0105 A79-16485
- HIGH ENERGY ELECTRONS**
- Application of electron beams in space for energy storage and optical beam generation  
21 p0108 A79-16606
- Electrons of high perpendicular energy in the low-density regime of tokamaks  
22 p0270 A79-24852
- Radiation energy conversion in space  
22 p0284 A79-26595
- On the motion of runaway electrons in momentum space --- analysis for multi-component plasma in tokamaks  
22 p0291 A79-27880
- HIGH ENERGY FUELS**
- High energy MHD fuels development program  
[AD-A060156] 21 p0216 A79-14239
- HIGH FIELD MAGNETS**
- Energy sources and conventional magnets --- for tokamak experiment Power Reactor toroidal field  
21 p0079 A79-14791

## HIGH POWER LASERS

- Flywheel energy storage system for JT-60 toroidal field coil  
21 p0112 A79-16729
- Design of a D-shaped toroidal field coil  
21 p0156 A79-19083
- Superconducting magnets - Present status and problems  
22 p0311 A79-31009
- HIGH POWER LASERS**  
Power from space by laser  
22 p0284 A79-26596
- HIGH PRESSURE**  
Advanced industrial gas turbine cooling and high pressure compressor technology  
21 p0004 A79-10041
- HIGH SPEED**  
NACA research on hydrogen for high altitude aircraft  
22 p0338 A79-16999
- HIGH STRENGTH STEELS**  
Wind turbine generator application places unique demands on tower design and materials  
22 p0240 A79-20826
- HIGH TEMPERATURE**  
Hydrogen production from high temperature electrolysis and fusion reactor  
21 p0015 A79-10126
- A compound parabolic concentrator for a high temperature solar collector requiring only twelve tilt adjustments per year  
21 p0134 A79-17439
- High temperature solar collector of optimal concentration - Non-focusing lens with secondary concentrator  
21 p0135 A79-17448
- Energy storage by the use of high temperature electrochemical systems  
21 p0148 A79-17992
- Development of high temperature fuel cell battery [BNFT-PB-T-77-17]  
22 p0342 A79-17344
- A low cost high temperature sun tracking solar energy collector  
22 p0366 A79-21390
- HIGH TEMPERATURE AIR**  
High temperature oxidizer preheater --- for fossil fuel MHD energy conversion  
21 p0106 A79-16487
- Solar heating performance of the Toshiba Solar House No. 1  
21 p0137 A79-17465
- Space heating with solar all-air systems - CSU Solar House II  
21 p0137 A79-17467
- Combustion of pulverized coal in high temperature preheated air [AIAA PAPER 79-0298]  
21 p0158 A79-19654
- Experimental measurements and correlations of Nusselt number for MHD high temperature air preheaters [ASME PAPER 78-WA/HT-22]  
21 p0161 A79-19809
- Optimization of the flow passage geometry for air heating solar collectors  
22 p0316 A79-31403
- Cost analysis of new and retrofit hot-air type solar assisted heating systems [NASA-TM-78186]  
21 p0173 A79-10519
- MSFC hot air collectors [NASA-TM-78206]  
21 p0196 A79-12556
- Thermal performance evaluation of MSFC hot air collectors with various flow channel depth [NASA-CR-150900]  
22 p0348 A79-18449
- HIGH TEMPERATURE ENVIRONMENTS**  
A high temperature Rankine binary cycle for ground and space solar engine applications  
21 p0108 A79-16613
- Differential pressure measurements in high temperature environments  
21 p0144 A79-17599
- HIGH TEMPERATURE GAS COOLED REACTORS**  
The nuclear closed-cycle gas turbine /GT-HTGR/ - A utility power plant for the year 2000 [AIAA PAPER 79-0191]  
21 p0157 A79-19590
- Substitute natural gas from coal using high-temperature reactor heat - Project 'Prototype Plant Nuclear Process Heat'  
22 p0264 A79-23827
- Gasification of coal with high-temperature reactor heat - Investigations concerning the market and the economics  
22 p0264 A79-23828

## SUBJECT INDEX

- HIGH TEMPERATURE GASES**  
Influence of cyclic wall-to-gas heat transfer in the cylinder of the valved hot-gas engine  
21 p0024 A79-10201
- HIGH TEMPERATURE NUCLEAR REACTORS**  
Engineering and bench-scale studies of the sulfur-iodine cycle at General Atomic  
21 p0015 A79-10127
- HIGH TEMPERATURE PLASMAS**  
The TELEC - A plasma type of direct energy converter --- Thermo-Electronic Laser Energy Converter for electric power generation  
21 p0110 A79-16629
- 200-kv Blumlein transmission line for ultrafast toroidal theta-pinch  
22 p0297 A79-28917
- Interpretation of cyclotron radiation spectra from runaway discharges in TFR  
22 p0313 A79-31185
- A ray-tracing analysis of fast-wave heating of tokamaks  
22 p0313 A79-31186
- HIGH TEMPERATURE RESEARCH**  
Materials --- for high temperature MHD technology  
21 p0106 A79-16491
- HIGH TEMPERATURE TESTS**  
Melting multifoil insulation for KIPS emergency cooling --- Kilowatt Isotope Power System  
21 p0023 A79-10191
- New instrumentation for high temperature and hemispherical measurements of selective surfaces --- for solar energy conversion  
22 p0294 A79-28152
- HIGH VOLTAGES**  
Large-scale cryopumping for controlled fusion  
21 p0085 A79-15330
- HIGHWAYS**  
Status of alcohol fuels utilization technology for highway transportation [HCP/H2923-01]  
21 p0201 A79-13190
- HISTORIES**  
History of solar energy applications - Solar energy yesterday, today and tomorrow  
21 p0089 A79-15852
- Historical and projected power requirements  
21 p0169 A79-10125
- HOLLOW**  
Dual membrane hollow fiber fuel cell and method of operating same [NASA-CASE-NPO-13732-1]  
21 p0172 A79-10513
- HOMOPOLAR GENERATORS**  
Homopolar generator energy storage for fusion reactors  
22 p0304 A79-29942
- HONEYCOMB STRUCTURES**  
An approximate equation for predicting the solar transmittance of transparent honeycombs  
21 p0042 A79-11877
- Performance of a honeycomb type flat plate collector with serpentine tube  
21 p0054 A79-13579
- Use of monolithic structures for the short term storage of solar energy  
21 p0121 A79-17327
- A comparison among various flat plate collectors with honeycomb structures  
21 p0128 A79-17392
- An interferometric investigation heat transfer in honeycomb solar collector cells  
21 p0129 A79-17398
- Anticonvective antiradiative systems --- for solar collectors  
21 p0132 A79-17420
- Honeycomb type flat plate collectors - Experiments leading to drinking straw --- heat retention material for solar steam generation  
21 p0132 A79-17424
- The honeycomb heat trap - Its application in flat plate solar collectors  
22 p0322 A79-31447
- HOT ELECTRONS**  
Macroscopic stability and beta limit in the ELMO Bumpy Torus  
22 p0291 A79-27876
- HUBS**  
A small horizontal axis wind turbine feeding power into the utility grid  
21 p0074 A79-14703

- Alternative fuels and combustion problems 21 p0051 A79-12978
- Future fuels in gas turbine engines 21 p0051 A79-12979
- Alternative fuels for reciprocating internal combustion engines 21 p0051 A79-12980
- Combustion of droplets and sprays of some alternative fuels 21 p0052 A79-12983
- Liquid-phase reactions of vaporizing hydrocarbon fuels 21 p0052 A79-12987
- Role of aromatics in soot formation 21 p0053 A79-12988
- Kinetics of nitric oxide formation in combustion 21 p0053 A79-12989
- The electric conductivity of a plasma of combustion products of hydrocarbon fuels with alkali impurity 21 p0167 A79-20415
- On future carburants. II --- alternative fuels from alcohols and hydrogen 22 p0296 A79-28439
- Water-cooled gas turbine technology development - Fuels flexibility [ASME PAPER 79-GT-72] 22 p0307 A79-30536
- Fundamental data needs for coal conversion technology appendices [TID-28152-APP] 21 p0187 A79-11512
- Characteristics and combustion of future hydrocarbon fuels 21 p0202 A79-13196
- Impact of future fuel properties on aircraft engines and fuel systems 21 p0202 A79-13197
- Behavior of nonmetallic materials in shale oil derived jet fuels and in high aromatic and high sulfur petroleum fuels --- compatibility of aircraft materials to fuels [AD-A060322] 21 p0226 A79-15203
- Alternative hydrocarbon fuels: Combustion and chemical kinetics --- synthetic aircraft fuels [AD-A061050] 22 p0338 A79-17011
- HYDROCARBONS**
- Hydrocarbon working fluid and operating conditions selection for the conventional geothermal binary cycle 21 p0015 A79-10124
- Specific heat variations in oil energy storage media and their economic implications [SAND-78-8672] 21 p0189 A79-11537
- Improved anodes for liquid hydrocarbon fuel cell [AD-A058456] 21 p0206 A79-13504
- Late diagenetic indicators of buried oil and gas. 2. Direct detection experiment at Cement and Garza fields, Oklahoma and Texas, using enhanced LANDSAT 1 and 2 images [E79-10099] 22 p0347 A79-18373
- HYDRODYNAMICS**
- Some heat transfer and hydrodynamic problems associated with superconducting cables (SPTL) [NASA-TN-79023] 21 p0226 A79-15267
- HYDROELECTRIC POWER STATIONS**
- Hydropower from a national point of view --- projects for future energy production 21 p0059 A79-13656
- Wave driven power generating system 21 p0059 A79-13657
- Development of industrial owned, small hydroelectric facilities 21 p0073 A79-14699
- Low head power generation with bulb turbines --- hydroelectric installations 21 p0074 A79-14705
- Power from glaciers - The hydropower potential of Greenland's glacial water 21 p0087 A79-15672
- A commentary on a methodology for assessment of the environmental impact of the electrical power system within the Connecticut River Basin 21 p0093 A79-15893
- Power generation using thermal vapor pumping and hydro-pumped storage - Thermal gradient utilization cycle /TGUC/ 21 p0095 A79-15914
- A proposed conceptual plan for integration of wind turbine generators with a hydroelectric system 21 p0098 A79-16107
- Regional analysis of potential water power 21 p0148 A79-17825
- Studies in retining tidal energy 21 p0152 A79-18115
- Thermoclines: A solar thermal energy resource for enhanced hydroelectric power production 22 p0237 A79-20730
- Optimal decisions for long-term operation of hydropower systems 22 p0245 A79-21473
- HYDROGEN**
- Thermodynamics of pressure plateaus in metal-hydrogen systems 22 p0238 A79-20772
- Hydrogen enrichment for low-emission jet combustion 22 p0244 A79-21347
- Coal liquefaction support studies. Task 1: Heat of reaction of hydrogen with coal slurries. Task 2: Heat transfer coefficient [ANL/CEN/PE-77-5] 21 p0216 A79-14242
- Hydrogen technology from thermonuclear research 22 p0338 A79-16997
- NACA research on hydrogen for high altitude aircraft 22 p0338 A79-16999
- HYDROGEN COMPOUNDS**
- Solar energy storage as hydrogen and bromine from hydrogen bromide 22 p0265 A79-24045
- HYDROGEN EMBRITTLEMENT**
- Hydrogen embrittlement and its control in hydrogen-fueled engine systems 22 p0366 A79-21429
- HYDROGEN ENGINES**
- Some problems and benefits from the hydrogen fueled spark ignition engine 21 p0016 A79-10130
- Hydrogen embrittlement and its control in hydrogen-fueled engine systems 22 p0366 A79-21429
- HYDROGEN FUELS**
- Utility fuel cells for biomass fuel 21 p0016 A79-10131
- Alternative fuels for reciprocating internal combustion engines 21 p0051 A79-12980
- Hydrogen economy - An alternative 21 p0096 A79-15925
- Solar fuels --- photochemical reaction kinetics and energy storage 21 p0149 A79-18009
- Drag reduction by cooling in hydrogen fueled aircraft 21 p0165 A79-20084
- The potential of liquid hydrogen as a military aircraft fuel 22 p0238 A79-20773
- Some environmental and safety aspects of using hydrogen as a fuel 22 p0238 A79-20774
- The hydrogen/hydride energy concept 22 p0252 A79-21717
- Cryohydrogen-fuel for tomorrow's commercial aircraft 22 p0289 A79-27656
- Hydrogen storage in FeTi - Surface segregation and its catalytic effect on hydrogenation and structural studies by means of neutron diffraction 22 p0312 A79-31156
- The influence of fuel composition on smoke emission from gas-turbine-type combustors - Effect of combustor design and operating conditions 22 p0323 A79-31510
- Combustion of hydrogen in a supersonic flow in a channel in the presence of a pseudodiscontinuity 22 p0324 A79-31845
- NACA research on hydrogen for high altitude aircraft 22 p0338 A79-16999
- New initiatives in high altitude aircraft 22 p0338 A79-17000
- Hydrogen embrittlement and its control in hydrogen-fueled engine systems 22 p0366 A79-21429
- HYDROGEN OXYGEN ENGINES**
- Velocity, temperature, and electrical conductivity profiles in hydrogen-oxygen MHD duct flows 22 p0279 A79-26184

# SUBJECT INDEX

# HYDROCARBON FUELS

## HUMAN FACTORS ENGINEERING

Inexpensive solar energy utilization in human settlements 21 p0104 A79-16470

## HUMAN WASTES

The natural and perturbed troposphere 21 p0179 N79-10636

## HYBRID PROPULSION

Fiat Research Center hybrid vehicle prototype [SAE PAPER 790014] 22 p0313 A79-31351  
Study of heat engine/flywheel: Hybrid propulsion configuration with electrical transmission system. Phase 2: Design definition [ALO-41/2] 21 p0185 N79-11493

## HYDRAULIC CONTROL

The application of hydraulics in the 2,000 kW wind turbine generator 22 p0288 A79-27400

## HYDRAULIC EQUIPMENT

The brake system for the DOE/Sandia 17-meter vertical axis wind turbine 21 p0067 A79-14289

Solar engines - The thermal wheel and beyond 21 p0095 A79-15909

The design and evaluation of a hydraulic-solar powered tracking device 21 p0136 A79-17458

Modeling the champagne effect in compressed air energy storage 22 p0280 A79-26190

Performance of a hydraulic air compressor for use in Compressed Air Energy Storage power systems 22 p0280 A79-26191

Review of liquid piston pumps and their operation with solar energy [ASME PAPER 79-SOL-4] 22 p0308 A79-30542

Design package for programmable controller and hydronic subsystem [NASA-CR-161151] 22 p0371 N79-21619

## HYDRAULICS

New energy from an old source - Hydrogen from falling water 21 p0015 A79-10129

## HYDRIDES

Survey of the different types of hydrides --- for hydrogen energy storage 22 p0247 A79-21678

Mixing effects of two different types of hydrides --- phase behaviors and energy storage applications 22 p0251 A79-21714

HYCSOS - A system for evaluation of hydrides as chemical heat pumps 22 p0252 A79-21716

High energy metal hydride fuel cell power source [AD-A056491] 21 p0184 N79-11485

## HYDROCARBON COMBUSTION

Alternative hydrocarbon fuels: Combustion and chemical kinetics; SQUID Workshop, Loyola College, Columbia, Md., September 7-9, 1977, Technical Papers 21 p0051 A79-12977

Combustion chemistry of chain hydrocarbons 21 p0052 A79-12986

Correlations of catalytic combustor performance parameters 21 p0081 A79-14956

Combustion of pulverized coal in high temperature preheated air [AIAA PAPER 79-0298] 21 p0158 A79-19654

Burn coal cleanly in a fluidized bed - The key is in the controls 22 p0282 A79-26374

Kinetic modeling of pyrolysis and hydrogasification of carbonaceous materials --- converting wood waste char to clean fuels 21 p0179 N79-11150

Combustion kinetics of selected aromatic hydrocarbons [AD-A059381] 21 p0215 N79-14184

## HYDROCARBON FUEL PRODUCTION

Energy from biomass through hydrolysis of wood 21 p0003 A79-10036

Colorado's oil-shale resource for vertical modified in-situ processes 21 p0005 A79-10046

Comparison of shale oils from different sources produced by controlled-state retort 21 p0005 A79-10047

Underground thermal generation of hydrocarbons from dry, southwestern coals 21 p0005 A79-10050

Exploratory research in coal conversion 21 p0007 A79-10061

Novel technology for conversion of methanol and synthesis gas to hydrocarbons 21 p0007 A79-10064

An overview of coal preparation --- for producing clean fuel through desulfurization 21 p0044 A79-12115

Catalysis in coal conversion --- Book 21 p0051 A79-12873

Liquid fuels from biomass [AIAA PAPER 78-1781] 21 p0063 A79-13876

Recovery of oil from oil shale - An overall technological perspective 21 p0073 A79-14698

SRC-II - Review of development and status --- Solvent Refined Coal process for fuel oil production 21 p0092 A79-15887

H-Coal pilot plant project and status of commercial development at Ashland --- coal gasification producing hydrogen and hydrocarbons 21 p0092 A79-15888

Status and outlook of the Exxon Donor Solvent coal liquefaction process development 21 p0092 A79-15889

SNL production by the Rockgas process 21 p0093 A79-15896

Petroleum plantations --- hydrocarbon fuels from artificial photosynthesis and plants 21 p0095 A79-15910

Production and use of low and medium Btu gas 21 p0095 A79-15912

An economic analysis of synthetic fuels production from eastern oil shale via hydrotret processing 22 p0264 A79-23780

Evaluation of commercial catalysts for the Fischer-Tropsch reaction --- for coal conversion to liquid fuel or chemical feedstock 22 p0272 A79-25124

Wilson parameters for the system H<sub>2</sub>, N<sub>2</sub>, CO, CO<sub>2</sub>, CH<sub>4</sub>, H<sub>2</sub>S, CH<sub>3</sub>OH, and H<sub>2</sub>O --- for cold methanol absorption in coal gasification 22 p0282 A79-26462

Factors affecting bitumen recovery by the hot water process 22 p0282 A79-26463

Moessbauer spectroscopy of iron in coal and coal hydrogenation products 22 p0282 A79-26464

Catalytic hydrodesulfurization and liquefaction of coal - Batch autoclave studies 22 p0282 A79-26465

Coal gasification studies. I - Single stage complete gasification of coal using water as the hydrogen source 22 p0283 A79-26466

Coke formation on hydrodesulphurization catalysts 22 p0283 A79-26470

Electrical induction heating of solid fossil fuels in situ - Some estimates 22 p0304 A79-30215

Gasification of raw lignite in the tube-furnace gasifier 22 p0310 A79-30996

Aviation fuels from coal 22 p0325 A79-31913

## HYDROCARBON FUELS

The status of alcohol fuels utilization technology for highway transportation 21 p0003 A79-10035

H-coal products for direct application to power generation --- coal liquefaction derived fuels 21 p0006 A79-10056

Characteristics and combustion of future hydrocarbon fuels 21 p0036 A79-11599

Impact of future fuel properties on aircraft engines and fuel systems 21 p0036 A79-11600

Alternative hydrocarbon fuels: Combustion and chemical kinetics; SQUID Workshop, Loyola College, Columbia, Md., September 7-9, 1977, Technical Papers 21 p0051 A79-12977

# SUBJECT INDEX

# HYDROGEN-BASED ENERGY

## HYDROGEN OXYGEN FUEL CELLS

Preparation and ionic conductivity of H<sub>3</sub>O<sup>+</sup>/β alumina --- for hydrogen-oxygen fuel cells  
21 p0040 A79-11821

Generation of electrical energy from hydrogen and oxygen by means of fuel cells  
21 p0059 A79-13662

Development of advanced fuel cell system [NASA-CR-159443]  
21 p0196 A79-12553

## HYDROGEN PEROXIDE

Development and evaluation of a 600-kWh lithium-hydrogen peroxide reserve power system  
21 p0011 A79-10095

## HYDROGEN PLASMA

Properties of the plasma ions and the particle lifetime in ohmic heating in the L-2 stellarator  
22 p0244 A79-21428

Stabilization of drift loss-cone instability /DCI/ by addition of cold ions --- in collisional hydrogen plasma confinement  
22 p0291 A79-27882

## HYDROGEN PRODUCTION

Hydrogen production from high temperature electrolysis and fusion reactor  
21 p0015 A79-10126

Engineering and bench-scale studies of the sulfur-iodine cycle at General Atomic  
21 p0015 A79-10127

A copper oxide-copper sulfate water-splitting cycle  
21 p0015 A79-10128

New energy from an old source - Hydrogen from falling water  
21 p0015 A79-10129

Progress report on hydrogen production and utilization for community and automotive power  
21 p0016 A79-10132

Hydrogen production in a solar-hydrogen economy  
21 p0037 A79-11796

Advanced electrolysis in alkaline solution --- for hydrogen production  
21 p0037 A79-11798

Electrochemical-ellipsometric studies of oxide films formed on nickel during oxygen evolution  
21 p0038 A79-11799

Electrocatalysis, charge-transfer and the states of H adsorption in the hydrogen evolution reaction  
21 p0038 A79-11801

Problems, status, and prospects of a solar hydrogen economy  
21 p0059 A79-13658

Hydrogen production by conventional and modified water electrolysis  
21 p0059 A79-13659

On the thermal and thermo-electrolytical generation of hydrogen by solar energy  
21 p0059 A79-13660

A hybrid thermochemical hydrogen production cycle using solar energy process heat [AIAA PAPER 78-1779]  
21 p0062 A79-13874

H-Coal pilot plant project and status of commercial development at Ashland --- coal gasification producing hydrogen and hydrocarbons  
21 p0092 A79-15888

Solar-hydrogen energy system and solar-hydrogen production methods  
21 p0104 A79-16463

Solar hydrogen production at high temperatures  
21 p0104 A79-16464

Technical and economic feasibility of making fertilizer from wind energy, water, and air  
21 p0142 A79-17512

Development of a 1 kW fuel cell aggregate with acid electrolyte  
21 p0148 A79-17994

Thermal calculations for the reactor of a solar-power unit to produce hydrogen by thermolysis of water  
21 p0167 A79-20360

The thermochemical decomposition of water using bromine and iodine  
22 p0238 A79-20770

Problems around Fe-Cl cycles --- thermochemical decomposition of water hydrogen production  
22 p0238 A79-20771

Photoelectrolysis of water with semiconductors  
22 p0259 A79-23343

Applications of cryogenic technology. Volume 7 - Proceedings of the Conference on Cryogenic Energy Systems, Oak Brook, Ill., May 16-18, 1978  
22 p0289 A79-27651

Hydrogen via gasification - Today and tomorrow  
22 p0289 A79-27652

Progress in solid polymer electrolyte water electrolysis --- for large-scale hydrogen production  
22 p0289 A79-27653

Hydrogen via thermochemistry and future water-splitting technologies  
22 p0289 A79-27654

An overview of the STOR hydrogen energy program  
22 p0289 A79-27655

The economics of hydrogen and carbon monoxide separation with cuprous ammonium lactate solutions --- hydrogen production from coal  
22 p0299 A79-29313

A new thermochemical process for hydrogen production  
22 p0312 A79-31153

Direct thermomagnetic splitting of water  
22 p0312 A79-31154

Thermochemical production of hydrogen from water [LA-UR-78-652]  
21 p0180 A79-11236

Catalytic conversion of coal energy to hydrogen [FE-2206-14]  
21 p0180 A79-11239

Photoproduction of hydrogen by marine blue-green algae [FE-287508/6]  
22 p0343 A79-17354

## HYDROGEN SULFIDE

Desulfurization and sulfidation of coal and coal char  
21 p0045 A79-12120

A methodology for assessing the potential impact on air quality resulting from geothermal resource development in the Imperial Valley  
21 p0116 A79-17262

Wilson parameters for the system H<sub>2</sub>, N<sub>2</sub>, CO, CO<sub>2</sub>, CH<sub>4</sub>, H<sub>2</sub>S, CH<sub>3</sub>OH, and H<sub>2</sub>O --- for cold methanol absorption in coal gasification  
22 p0282 A79-26462

## HYDROGEN-BASED ENERGY

Silver-hydrogen, a long life light weight energy storage system --- design for spacecraft  
21 p0001 A79-10012

Progress report on hydrogen production and utilization for community and automotive power  
21 p0016 A79-10132

Model predictions for the stability of ternary metallic hydrides  
21 p0038 A79-11802

Hydrogen storage by LaNi<sub>5</sub> - Fundamentals and applications  
21 p0038 A79-11803

Absorption of hydrogen by the intermetallics PdH<sub>1.5</sub> and LaNi<sub>4</sub>Cu and a correlation of cell volumes and desorption pressures  
21 p0038 A79-11804

New alloy systems for hydrogen storage  
21 p0038 A79-11806

Problems, status, and prospects of a solar hydrogen economy  
21 p0059 A79-13658

The wind as a potential energy source in future hydrogen technology  
21 p0059 A79-13661

Hydrogen economy - An alternative  
21 p0096 A79-15925

Hydrides for energy storage; Proceedings of the International Symposium, Geilo, Norway, August 18-19, 1977  
22 p0247 A79-21676

The prospects of hydrogen as an energy carrier for the future  
22 p0247 A79-21677

Survey of the different types of hydrides --- for hydrogen energy storage  
22 p0247 A79-21678

Structure and bonding in metal hydrides  
22 p0247 A79-21679

Thermodynamics of metal, alloy and intermetallic/hydrogen systems  
22 p0248 A79-21680

Structural studies of hydrides by neutron diffraction  
22 p0248 A79-21681

- Localization and diffusion of hydrogen in lanthanum-nickel compounds 22 p0248 A79-21682
- Nuclear magnetic resonance studies of metal hydrides 22 p0248 A79-21683
- NMR studies of hydrogen relaxation and diffusion in  $\text{TiFeH}/x/$  and  $\text{TiFe}/1-y/\text{Mn}/y/\text{H}/x/$  22 p0248 A79-21684
- Electronic states of concentrated Pd-H alloys from de Haas-van Alphen measurements 22 p0248 A79-21686
- Kinetics of hydrogen absorption and desorption --- for energy storage 22 p0248 A79-21687
- The storage and release of hydrogen from magnesium alloy hydrides for vehicular applications 22 p0249 A79-21688
- High temperature thermodynamics of the solid solutions of hydrogen and deuterium in palladium and in the Pd/0.9/Ag/0.1/ alloy 22 p0249 A79-21689
- Calculated heats of formation of metal and metal alloy hydrides 22 p0249 A79-21690
- Acoustic emissions during hydride formation 22 p0249 A79-21691
- Magnetic and electrical properties of rare earth and rare earth intermetallic hydrides 22 p0249 A79-21692
- Hydrogen absorption in rare earth intermetallic compounds 22 p0249 A79-21693
- Some applications of  $\text{LaNi}_5$ -type hydrides --- using reversible reaction with hydrogen working fluid for heat storage 22 p0249 A79-21694
- Metal hydride electrodes for electrochemical energy storage 22 p0249 A79-21695
- The plateau pressure of RE  $\text{Ni}_5$  and RE  $\text{Co}_5$  hydrides --- in hydride formation 22 p0250 A79-21698
- Synthesis and properties of useful metal hydrides - A review of recent work at Brookhaven National Laboratory 22 p0250 A79-21699
- The use of FeTi-hydride for production and storage of suprapure hydrogen 22 p0250 A79-21700
- Hydride formation of C14-type Ti alloy 22 p0250 A79-21701
- Hydrogen sorption properties in binary and pseudobinary intermetallic compounds 22 p0250 A79-21702
- The metallurgy and production of rechargeable hydrides --- for hydrogen storage 22 p0250 A79-21703
- A new rationale for the hysteresis effects observed in metal-hydrogen systems 22 p0250 A79-21704
- Heat transfer characteristics of porous metallic matrix metal-hydrides 22 p0251 A79-21706
- The effect of induced disorder on the hydrogenation behaviour of the phase ZrCo 22 p0251 A79-21707
- Electrochemical utilization of metal hydrides 22 p0251 A79-21709
- Hydrogen storage electrode systems 22 p0251 A79-21710
- Hydrogen electrochemical storage by substituted  $\text{LaNi}_5$  compounds 22 p0251 A79-21711
- Mixing effects of two different types of hydrides --- phase behaviors and energy storage applications 22 p0251 A79-21714
- Applications of metal hydrides --- emphasizing use as energy storage media 22 p0251 A79-21715
- The hydrogen/hydride energy concept 22 p0252 A79-21717
- Synthetic oil from coal - The economic impact of five alternatives for making hydrogen from coal and steam 22 p0262 A79-23719
- An overview of the STOR hydrogen energy program 22 p0289 A79-27655
- Hydrogen - Potential key to tomorrow's energy utility 22 p0289 A79-27657
- The utilization of LH2 and LNG cold for generation of electric power by a cryogenic-type Stirling engine 22 p0311 A79-31020
- Hydrogen energy storage program: Five-year plan [DOE/ET-0046] 21 p0175 A79-10544
- Fabrication and testing of silver-hydrogen cells [NASA-CR-159431] 22 p0334 A79-16374
- HYDROGENATION**
- Prerrefining true in situ shale oil 21 p0004 A79-10044
- Coal conversion by flash hydrolysis and hydrogasification 21 p0006 A79-10055
- H-coal products for direct application to power generation --- coal liquefaction derived fuels 21 p0006 A79-10056
- Fluid-bed carbonization/desulfurization of Illinois coal by the Clean Coke Process - PDU studies --- Process Development Unit 21 p0045 A79-12121
- The H-Coal project --- catalytic hydrogenation of coal 21 p0145 A79-17635
- Hydrides of rare earth-nickel compounds - Structure and formation enthalpies 22 p0250 A79-21697
- The plateau pressure of RE  $\text{Ni}_5$  and RE  $\text{Co}_5$  hydrides --- in hydride formation 22 p0250 A79-21698
- Synthesis and properties of useful metal hydrides - A review of recent work at Brookhaven National Laboratory 22 p0250 A79-21699
- Hydride formation of C14-type Ti alloy 22 p0250 A79-21701
- The effect of induced disorder on the hydrogenation behaviour of the phase ZrCo 22 p0251 A79-21707
- Rare earth and actinide intermetallics as hydrogenation catalysts 22 p0251 A79-21713
- Evaluation of commercial catalysts for the Fischer-Tropsch reaction --- for coal conversion to liquid fuel or chemical feedstock 22 p0272 A79-25124
- Coal gasification studies. II - Reduction in the presence of  $\text{I}_2$  with  $\text{H}_2$ , and  $\text{H}_2\text{O}/\text{H}_2$  metal, at pressures up to 3500 p.s.i. and temperatures of 600 C in all quartz reactors 22 p0283 A79-26468
- Coke formation on hydrodesulfurization catalysts 22 p0283 A79-26470
- The iron-titanium - hydrogen system: A transmission electron microscope /TEM/ study 22 p0285 A79-26947
- Hydrogen storage in FeTi - Surface segregation and its catalytic effect on hydrogenation and structural studies by means of neutron diffraction 22 p0312 A79-31156
- Phase equilibria in coal hydrogenation systems [PE-2334-6] 21 p0171 A79-10238
- HYDROGEOLOGY**
- Shallow magmatic reservoirs as heat source of geothermal systems - Preliminary interpretation of data available for the Neapolitan active volcanic areas 21 p0075 A79-14727
- Suggestions for a geochemical prospecting of geothermal systems - A first survey of the Italian thermal springs 21 p0075 A79-14737
- HYDROLOGY**
- Applying NASA remote sensing data to geologically related regional planning problems in Tennessee [E79-10095] 22 p0339 A79-17289
- HYDROLYSIS**
- Energy from biomass through hydrolysis of wood 21 p0003 A79-10036
- Coal desulfurization by low-temperature chlorinolysis 21 p0045 A79-12119
- A new thermochemical process for hydrogen production 22 p0312 A79-31153
- Direct thermomagnetic splitting of water 22 p0312 A79-31154



# SUBJECT INDEX

# INDIUM PHOSPHIDES

## HYDROSTATIC PRESSURE

- The use of ocean energy - A hydrostatic motor  
22 p0288 A79-27391
- Potential producibility and recovery of natural  
gas from geopressured aquifers of the Cenozoic  
sediments of the Gulf Coast Basin  
[FE-2025-3] 21 p0192 N79-11607

## HYDROXIDES

- An improved method for analysis of hydroxide and  
carbonate in alkaline electrolytes containing zinc  
21 p0035 A79-11546

## HYPERSONIC AIRCRAFT

- Recent advances in convectively cooled engine and  
airframe structures for hypersonic flight  
21 p0165 A79-20087

## HYSTERESIS

- A new rationale for the hysteresis effects  
observed in metal-hydrogen systems  
22 p0250 A79-21704

## ICE FLOES

- Power from glaciers - The hydropower potential of  
Greenland's glacial water  
21 p0087 A79-15672

## IDEAL GAS

- Analysis of a cylindrical imploding shock wave  
21 p0155 A79-18846

## IGNEOUS ROCKS

- Mining earth's heat - Hot dry rock geothermal energy  
22 p0258 A79-23280

## IGNITION

- Ignition/stabilization/atomization - Alternative  
fuels in gas turbine combustors  
21 p0052 A79-12982
- Shock-tube measurements of induction and  
post-induction rates for low-Btu gas mixtures  
--- derived from shale oil retorting and coal  
gasification  
21 p0083 A79-15245

## IGNITION LIMITS

- Selection of a characteristic quantity defining  
the self-ignition of a fuel in a stream  
21 p0114 A79-16786

## IGNITION SYSTEMS

- Four ignition INS Tokamak reactor systems: Design  
summary  
[ORNL/SUB-7117/25] 21 p0193 N79-11889

## ILLUMINANCE

- Performance of a new high-intensity silicon solar  
cell  
22 p0257 A79-22862

## ILLUMINATING

- Response of p-n junction solar cells to  
concentrated sunlight and partial illumination  
21 p0124 A79-17353

## IMAGE ENHANCEMENT

- Landsat - Developing techniques and applications  
in mineral and petroleum exploration  
21 p0111 A79-16725

## IMAGE PROCESSING

- A synoptic description of coal basins via image  
processing  
[NASA-CR-157970] 21 p0204 N79-13474

## IMAGING TECHNIQUES

- Two-dimensional monochromatic X-ray imaging of  
laser-produced plasmas --- during implosions for  
laser fusion  
22 p0296 A79-28366

## IMPACT PREDICTION

- Hail risk model for solar collectors  
21 p0098 A79-16103

## IMPACT RESISTANCE

- Simulated hail impact testing of photovoltaic  
solar panels  
21 p0098 A79-16116

## IMPACT TESTS

- Simulated hail impact testing of photovoltaic  
solar panels  
21 p0098 A79-16116

## IMPERIAL VALLEY (CA)

- A methodology for assessing the potential impact  
on air quality resulting from geothermal  
resource development in the Imperial Valley  
21 p0116 A79-17262

- Geothermal energy in Imperial County, California -  
Environmental, socio-economic, demographic, and  
public opinion research conclusions and policy  
recommendations  
22 p0265 A79-24046

## IMPLOSIONS

- Compact fusion reactors using controlled imploding  
liners  
21 p0018 A79-10151
- Measurements of compressed core density of  
laser-imploded targets by x-ray continuum-edge  
shift  
21 p0154 A79-18479
- Analysis of a cylindrical imploding shock wave  
21 p0155 A79-18846
- An overview of design space for small fusion targets  
22 p0253 A79-22241
- Two-dimensional monochromatic X-ray imaging of  
laser-produced plasmas --- during implosions for  
laser fusion  
22 p0296 A79-28366

## IMPURITIES

- Ash deposits and corrosion due to impurities in  
combustion gases; Proceedings of the  
International Conference, New England College,  
Henniker, N.H., June 26-July 1, 1977  
21 p0080 A79-14926
- Performance of a closed-cycle MHD  
generator with  
molecular impurities  
22 p0283 A79-26524
- The effects of wall temperature on light  
impurities in Alcator --- tokamak device  
22 p0313 A79-31188

## INCENTIVE TECHNIQUES

- Analysis of federal incentives used to stimulate  
energy production  
[PHL-2410] 21 p0210 N79-13539

## INCENTIVES

- Costs and impacts of financial incentives for  
solar energy systems  
21 p0119 A79-17296
- Industrialization study --- impact of government  
incentives and barriers on decision making in  
the industrial production of photovoltaics  
[NASA-CR-157953] 21 p0200 N79-12970

## INCIDENCE

- Calculation of solar energy incident on  
non-horizontal surfaces over Turkey  
22 p0253 A79-22266
- Angle-of-incidence effects in  
electron-beam-deposited SnO<sub>2</sub>/Si solar cells  
22 p0272 A79-25069

## INCIDENT RADIATION

- Measurement and modelling of shortwave radiation  
on inclined surfaces  
22 p0242 A79-21062
- Radiation regime of inclined surfaces --- Russian  
book on solar energy engineering and  
microclimatology  
22 p0282 A79-26353

## INCINERATORS

- Disposal of industrial wastes by combustion:  
Present state-of-the-art. Volume 3 --- Book  
21 p0036 A79-11675

## INCLINATION

- Inclination dependence of pyranometer sensitivity  
--- for solar collector testing  
22 p0295 A79-28154

## INCONEL (TRADEMARK)

- Characteristics of combustion-heated thermionic  
diodes  
21 p0026 A79-10215

## INDEPENDENT VARIABLES

- Electrolysis of zinc. Statistical model of the  
process parameters for an industrial cell  
[BLL-RTS-11317] 22 p0345 N79-17984

## INDIUM COMPOUNDS

- Potential for low cost, high efficiency solar  
cells using indium tin oxide on semiconductor  
/OSOS/ solar cells  
21 p0122 A79-17338
- Preparation and properties of pure and tin doped  
indium oxide selective coatings  
21 p0127 A79-17381

## INDIUM PHOSPHIDES

- High efficiency solar cells based on indium  
phosphide  
21 p0042 A79-11968

## INDUCTION HEATING

### INDUCTION HEATING

Electrical induction heating of solid fossil fuels in situ - Some estimates 22 p0304 A79-30215

### INDUCTORS

Theoretical and computational analysis of MHD machines with two-layer windings and half-filled slots and the inductor edges 22 p0298 A79-29286

### INDUSTRIAL ENERGY

Energy distribution and storage alternates with a centralized heat source 21 p0013 A79-10112

Potential of the Stirling engine for stationary power applications in the 500-2000 HP range 21 p0025 A79-10211

Scaling up coal liquids 21 p0031 A79-10475

Future solar total energy markets for the U.S. industrial sector 21 p0062 A79-13870

[AIAA PAPER 78-1773] Preliminary design of solar total energy - Large scale experiment at Shenandoah, Georgia 21 p0062 A79-13873

[AIAA PAPER 78-1776] Development of industrial owned, small hydroelectric facilities 21 p0073 A79-14699

Environmental impacts of industrial energy systems in the coastal zone 21 p0075 A79-14722

Market penetration for CTEC 21 p0094 A79-15903

Production and use of low and medium Btu gas 21 p0095 A79-15912

Solid waste and coal firing in industrial boilers 21 p0096 A79-15919

Advanced processes for more efficient use of forest products residual material 21 p0096 A79-15919

Opportunities for direct use of geoheat in Central America and other tropical countries 21 p0097 A79-16074

Input-output method applied to energy planning 21 p0112 A79-16737

A solar heating and cooling system for an industrial plant located in southern Europe 21 p0139 A79-17480

Use of solar energy for industrial process heat 21 p0143 A79-17524

Gas turbine with waste heat utilization - Low investment costs and high fuel use efficiency 21 p0168 A79-20448

Thermal storage for industrial process and reject heat 22 p0243 A79-21300

Industrial aspects in solar energy instruction 22 p0254 A79-22274

Industrial cogeneration - Problems and promise --- waste heat utilization from electricity production 22 p0265 A79-24047

Solar energy for industrial process steam 22 p0267 A79-24315

Medium-power /100-1000 kWe/ solar power plants using distributed collectors 22 p0269 A79-24622

Current status and prospects for low-temperature solar energy 22 p0269 A79-24623

Control system for solar hot water system 22 p0321 A79-31442

Applications of thermal energy storage to process heat and waste heat recovery in the iron and steel industry 21 p0183 A79-11473

[NASA-CR-159397] Thermal storage for industrial process and reject heat 21 p0183 A79-11481

[NASA-TM-789994] Energy analysis 21 p0187 A79-11513

[NP-23145] Some measures of regional-industrial interfuel substitution potentials 21 p0208 A79-13525

[BNL-24368] Energy use in Japan and the United States 21 p0221 A79-14578

[BNL-23101] Energy and economic analysis of industrial process heat recovery with heat pumps 22 p0331 A79-16210

Industrial energy conservation 22 p0333 A79-16353

[GPO-24-067]

## SUBJECT INDEX

Electrolysis of zinc. Statistical model of the process parameters for an industrial cell [BLL-RTS-11317] 22 p0345 A79-17984

Thermal storage technologies for solar industrial process heat applications [NASA-TM-79130] 22 p0360 A79-20498

The role of thermal energy storage in industrial energy conservation [NASA-TM-79122] 22 p0368 A79-21550

### INDUSTRIAL PLANTS

A technical analysis for cogeneration systems with potential applications in twelve California industrial plants --- energy saving heat-electricity utility systems 21 p0011 A79-10099

Disposal of industrial wastes by combustion: Present state-of-the-art. Volume 3 --- Book 21 p0036 A79-11675

Conservation where it counts: Energy management systems [PB-289837/7] 22 p0372 A79-21628

### INDUSTRIAL SAFETY

A literature review-problem definition studies on selected toxic chemicals. Volume 1: Occupational health and safety aspects of diesel fuel and white smoke generated from it [AD-A056018] 21 p0192 A79-11686

### INDUSTRIAL WASTES

New processes for the recovery of resource materials from coal combustion wastes 21 p0007 A79-10065

Thermal energy storage for industrial waste heat recovery 21 p0012 A79-10101

Disposal of industrial wastes by combustion: Present state-of-the-art. Volume 3 --- Book 21 p0036 A79-11675

Industrial wastes to energy 21 p0096 A79-15916

The fate of trace elements in coal after combustion 21 p0116 A79-17250

Weak points of our prediction models for raw materials strategy --- waste materials and scrap recycling 22 p0265 A79-24040

Factors affecting bitumen recovery by the hpt water process 22 p0282 A79-26463

Sampling and analysis of synthetic fuel processes --- coal gasification and liquefaction effluent analysis 22 p0284 A79-26538

Utilisation of solid waste 22 p0304 A79-30204

Proceedings of the Engineering Foundation Conference on Clean Combustion of Coal [PB-282949/7] 21 p0171 A79-10243

Nitrogen oxide air pollution. Volume 2, part 1: Control technology. A bibliography with abstracts [NTIS/PS-78/0971/8] 21 p0199 A79-12591

Regional air pollution study: Heat emission inventory [PB-284081/7] 21 p0200 A79-12602

Pollutants from synthetic fuels production: Facility construction and preliminary tests --- coal gasification plant effluents [PB-287730/6] 22 p0339 A79-17027

### INDUSTRIES

Industrial international data base: Energy analysis methodology. Rational use of energy program pilot study [NATO/CCNS-75] 21 p0206 A79-13508

### INERTIA PRINCIPLE

An introduction to the variable inertia flywheel /VIF/ [ASME PAPER 79-APM-5] 22 p0298 A79-29064

### INERTIAL FUSION (REACTOR)

Fusion power with particle beams 21 p0034 A79-11121

Heavy-ion beam inertial-confinement fusion 21 p0054 A79-13448

### INERTIAL PLATFORMS

Space platforms for building large space structures 21 p0032 A79-10511

### INVESTIGATION

Applying NASA remote sensing data to geologically related regional planning problems in Tennessee [E79-10095] 22 p0339 A79-17289

# SUBJECT INDEX

# INSOLATION

## INFORMATION DISSEMINATION

Coal research: Data systems and information transfer  
[ORAU-133] 21 p0232 N79-15830

## INFORMATION MANAGEMENT

Energy information data base. Guide to abstracting and indexing  
[TID-4583-R1] 21 p0184 N79-11488

## INFORMATION RETRIEVAL

How to tap NASA developed technology 21 p0164 A79-19896

## INFORMATION SYSTEMS

A survey of energy information systems and its implications for industrial energy management 21 p0072 A79-14685

A planning and information system for strategic energy policy assessment --- Book 22 p0259 A79-23600

The CCMS solar energy pilot study system performance reporting format 22 p0275 A79-25930

Industrial international data base: Energy analysis methodology. Rational use of energy program pilot study  
[NATO/CCMS-75] 21 p0206 N79-13508

Integrated safeguards information System (ISIS), executive summary --- nuclear power plant and fissionable materials security  
[PB-286869/3] 21 p0223 N79-14934

A computerized reporting and monitoring system for geothermal energy development  
[LBL-8483] 22 p0369 N79-21555

## INFRARED ABSORPTION

Studies on the selective absorption surface on stainless steel --- for flat type solar collectors 21 p0127 A79-17378

On the use of grating or mesh selective filters to increase the efficiency of flat plate solar collectors 21 p0127 A79-17380

Selective absorption of solar energy by ultrafine metal particles 21 p0127 A79-17382

Oil shale retorting - A correlation of selected infrared absorbance bands with process heating rates and oil yield 22 p0304 A79-29975

INFRARED IMAGERY  
Infrared remote sensing on geothermal areas by helicopter 22 p0256 A79-22620

INFRARED LASERS  
A new concept for solar pumped lasers 21 p0110 A79-16624

The TELEC - A plasma type of direct energy converter --- Thermo-Electronic Laser Energy Converter for electric power generation 21 p0110 A79-16629

Solar power satellites - The laser option 22 p0284 A79-26599

INFRARED RADIATION  
The measurement of optical properties of selective surfaces using a solar calorimeter 21 p0041 A79-11874

Computation of IR sky temperature and comparison with surface temperature --- for solar collector energy budgets 21 p0042 A79-11875

Selective covers for natural cooling devices --- in space 22 p0272 A79-25522

INFRARED REFLECTION  
Reduction of the heat loss flux of collectors by infrared reflecting coatings on cover plates 21 p0058 A79-13649

Colored stainless steel - A new type of selective absorber --- for solar thermal conversion 22 p0294 A79-28150

Electromagnetic radiation energy arrangement --- coatings for solar energy absorption and infrared reflection  
[NASA-CASE-W00-00428-1] 22 p0352 N79-19186

INFRARED SCANNERS  
Detection of internal defects in a liquid natural gas tank by use of infrared thermography 21 p0048 A79-12507

## INFRARED SPECTRA

Oil shale retorting - A correlation of selected infrared absorbance bands with process heating rates and oil yield 22 p0304 A79-29975

## INGREDIENTS

Dependence of the pour point of diesel fuels on the properties of the initial components  
[NASA-TN-75424] 22 p0364 N79-21217

## INJECTION LASERS

Electric power from laser fusion - The HYLIFE concept 21 p0030 A79-10249

## INLET FLOW

Effect of inlet temperature on the performance of a catalytic reactor 21 p0035 A79-11542

The MHD interaction and plasma properties in a shock tube driven disk generator with swirl 21 p0083 A79-15260

Effects of position of output electrodes in entrance region of open-cycle diagonal type MHD generator 21 p0153 A79-18468

## INOCULATION

Ionizing seed --- for open cycle MHD power generation 21 p0106 A79-16490

## INSOLATION

Annual available radiation for fixed and tracking collectors 21 p0042 A79-11880

General principles of multielement concentrating system design --- solar collectors 21 p0054 A79-13291

Results of measurements of solar radiation on surfaces of different orientations 21 p0055 A79-13622

Measurement of radiation intensity by means of a pyrheliometer 21 p0055 A79-13623

Irradiances on inclined surfaces --- from solar and sky radiation and earth albedo 21 p0055 A79-13624

The use of a sort of slide rule for the quick determination of solar irradiation of surfaces and through double glazing of arbitrary orientation and different inclination 21 p0055 A79-13625

Sun-position diagrams using examples from Plensburg to Mittenwald 21 p0055 A79-13626

Total solar irradiance at Table Mtn, California 1926-77 21 p0067 A79-14269

Estimating hourly solar radiation for one-axis tracking focusing collectors 21 p0071 A79-14678

Calibration standards and field instruments for the precision measurement of insolation 21 p0076 A79-14765

A probabilistic model of insolation for the Mojave desert-area 21 p0076 A79-14766

Solar energy and the flat plate collector - An annotated bibliography 21 p0090 A79-15858

The use and limitations of ASHRAE solar algorithms in solar energy utilization studies 21 p0101 A79-16416

Use of satellites in solar applications --- for insolation mapping and space power stations 21 p0104 A79-16468

The relationship between diffuse and total solar radiation in computer simulation of solar energy systems 21 p0119 A79-17309

Solar radiation studies for utilization of flat-plate collectors in an equatorial region 21 p0119 A79-17311

Flat plate collector dynamic evaluation 21 p0128 A79-17390

Performance of flat plate solar collector with fluid undergoing phase change 21 p0129 A79-17397

Optimum tilt for the flat plate collector 21 p0132 A79-17426

# **INSTALLATION MANUALS**

# **SUBJECT INDEX**

Availability of solar energy at Baghdad, Iraq -  
Performance and design data for flat plate  
collectors 21 p0133 A79-17428

Experiments in solar space heating and cooling for  
moderately insolated regions 21 p0137 A79-17464

Experimental investigation on solar house heating  
in northern India 21 p0140 A79-17495

Total solar radiation in Mexico using sunshine  
hours and meteorological data 21 p0150 A79-18026

1MW calorimetric receiver for Solar Thermal Test  
Facility [ASME PAPER 78-WA/SOL-7] 21 p0163 A79-19839

Differential insolation and turbidity measurements  
--- solar radiation attenuation by aerosols 22 p0241 A79-21056

Hourly vs daily method of computing insolation on  
inclined surfaces 22 p0242 A79-21164

Calculation of solar energy incident on  
non-horizontal surfaces over Turkey 22 p0253 A79-22266

Solar energy diagrams --- combining position and  
insolation data 22 p0253 A79-22267

Prediction of the behavior of a solar storage  
system by means of recurrent stochastic models  
--- of insolation 22 p0258 A79-23295

Isotropic distribution approximation in solar  
energy estimations --- diffuse insolation on  
tilted surface 22 p0262 A79-23753

Solar radiation charts --- monthly average  
insolation 22 p0263 A79-23763

Selected ordinates for total solar radiant  
property evaluation from spectral data 22 p0271 A79-25060

Radiation regime of inclined surfaces --- Russian  
book on solar energy engineering and  
microclimatology 22 p0282 A79-26353

Optics applied to solar energy IV; Proceedings of  
the Seminar, San Diego, Calif., August 30, 31,  
1978 22 p0293 A79-28140

A comparison of solar thermal energy collection  
using fixed and tracking collectors 22 p0293 A79-28146

Direct solar transmittance for a clear sky --- for  
insolation of solar conversion systems 22 p0296 A79-28361

Statistical analysis of solar radiation data in  
Montreal for solar energy utilization 22 p0322 A79-31452

**INSTALLATION MANUALS**  
Installation package for a solar heating system  
[NASA-CR-150876] 22 p0349 A79-18454

**INSTALLING**  
Solar system installation at Louisville, Kentucky  
[NASA-CR-150814] 21 p0172 A79-10518

**INSTRUMENT ERRORS**  
Measurement of solar radiation for energy conversion  
21 p0119 A79-17305

**INSTRUMENT PACKAGES**  
Transient attitude dynamics of satellites with  
deploying flexible appendages 21 p0047 A79-12325

Final system instrumentation design package for  
Decade 80 solar house [NASA-CR-150869] 22 p0354 A79-19455

**INSULATION**  
Development, characterization and evaluation of  
materials for open cycle MHD 22 p0361 A79-20504

Insulating wall boundary layer in a Faraday MHD  
generator [FE-23417] 22 p0365 A79-21310

**INSULATORS**  
Critical contributions in MHD power generation  
[FHL-2215-11] 22 p0362 A79-20511

Development, characterization and evaluation of  
materials for open cycle MHD [FHL-2004-8] 22 p0369 A79-21557

Development, testing and evaluation of MHD  
materials and component designs --- electrode  
and insulator systems for mhd generators  
[FE-2248-19] 22 p0369 A79-21558

**INTEGRAL CALCULUS**  
Analytical modelling of oil recovery by steam  
injection 22 p0358 A79-20434

**INTELSAT 5 SATELLITE**  
Intelsat V solar array design and development  
summary 21 p0002 A79-10018

**INTERFACES**  
On the role of interface states in MOS solar cells  
21 p0122 A79-17337

Interface properties and stability of Schottky  
barriers and MIS solar cells 21 p0123 A79-17342

**INTERMETALLICS**  
Model predictions for the stability of ternary  
metallic hydrides 21 p0038 A79-11802

Hydrogen storage by LaNi5 - Fundamentals and  
applications 21 p0038 A79-11803

Absorption of hydrogen by the intermetallics NdNi5  
and LaNi4Cu and a correlation of cell volumes  
and desorption pressures 21 p0038 A79-11804

Calcium/iron sulfide secondary cells 21 p0041 A79-11835

Thermodynamics of metal, alloy and  
intermetallic/hydrogen systems 22 p0248 A79-21680

Magnetic and electrical properties of rare earth  
and rare earth intermetallic hydrides 22 p0249 A79-21692

Hydrogen absorption in rare earth intermetallic  
compounds 22 p0249 A79-21693

Synthesis and properties of useful metal hydrides  
- A review of recent work at Brookhaven National  
Laboratory 22 p0250 A79-21699

The use of FeTi-hydride for production and storage  
of suprapure hydrogen 22 p0250 A79-21700

Hydrogen sorption properties in binary and  
pseudobinary intermetallic compounds 22 p0250 A79-21702

The metallurgy and production of rechargeable  
hydrides --- for hydrogen storage 22 p0250 A79-21703

Hydrogen electrochemical storage by substituted  
LaNi5 compounds 22 p0251 A79-21711

Rare earth and actinide intermetallics as  
hydrogenation catalysts 22 p0251 A79-21713

Method of producing a p-type or n-type alloy for  
direct thermoelectric energy conversion 22 p0260 A79-23615

**INTERNAL COMBUSTION ENGINES**  
Conversion of a standard single cylinder I.C.  
engine into a 'gamma' configuration air charged  
Stirling engine 21 p0024 A79-10202

Alternative fuels for reciprocating internal  
combustion engines 21 p0051 A79-12980

Flame emissivities - Alternative fuels 21 p0052 A79-12984

Road vehicles with combined, at least partly  
electrical driving systems and energy supplies  
22 p0301 A79-29494

Performance characteristics of automotive engines  
in the United States. First series: Report no.  
15 1975 Dodge Colt 98 CID (1.6 liters), 2V  
[PB-286075/7] 21 p0226 A79-15305

Performance characteristics of automotive engines  
in the United States. Second series: Report  
no. 5 1977 Ford 140 CID (2.3 liters), 2V ---  
fuel consumption and exhaust gases  
[PB-286076/5] 21 p0227 A79-15306

Performance characteristics of automotive engines  
in the United States Third series: Report No. 1  
1977 Volvo 130 CID (2.1 liters), F.I. --- fuel  
consumption and exhaust gases [PB-286077/3] 21 p0227 A79-15307

# SUBJECT INDEX

# IONIC REACTIONS

Performance characteristics of automotive engines in the United States. Second series, report no. 4: 1976 Chevrolet 85 CID (1.4 liters), IV [PB-286294/4] 21 p0227 N79-15308

Performance characteristics of automotive engines in the United States. Second series, report no. 7: 1977 Ford 171 CID (2.8 liters), 2V [PB-286296/9] 21 p0227 N79-15310

Performance characteristics of automotive engines in the United States. First series, report no. 17: 1975 Buick 455 CID (7.5 liters), 4V [PB-286298/5] 21 p0227 N79-15312

Performance characteristics of automotive engines in the United States. First series, report no. 18: 1976 Ford CID (6.6 liters), 2V --- fuel consumption and exhaust gases [PB-286299/3] 21 p0227 N79-15313

Performance characteristics of automotive engines in the United States. First series, report no. 19: 1975 Ford Windsor 351 CID (5.7 liters), 2V [PB-286300/9] 21 p0228 N79-15314

Performance characteristics of automotive engines in the United States. First series, report no. 20: 1975 Chevrolet 350 CID (5.7 liters) with dresser variable-area venturi system [PB-286301/7] 21 p0228 N79-15315

**INTERNATIONAL COOPERATION**

Summary of international energy research and development activities 1974-1976 --- Book 21 p0068 A79-14400

Analysis of alternatives for U.S. international cooperation in solar energy 21 p0116 A79-17277

The solar energy R & D programme of the European Communities 21 p0116 A79-17278

Energy policy of the European Economic Community 22 p0282 A79-26403

Status of the U.S./U.S.S.R. cooperative program for the development of open-cycle MHD power generators 22 p0290 A79-27661

Solar energy via satellites and international cooperation 22 p0310 A79-30952

**INTERNATIONAL TRADE**

Energy economics - A research analysis --- considering OPEC Cartel impact 21 p0115 A79-17222

**INTERPLANETARY SPACECRAFT**

The application of solar thermoelectric generators in near-sun missions 21 p0023 A79-10187

**INVENTORIES**

Energy information: Report to Congress [HTISUB/C/027-001] 21 p0221 N79-14576

An inventory of environmental impact models related to energy technologies [ORNL/EIS-147] 22 p0372 N79-21640

**INVERTED CONVERTERS (DC TO AC)**

Inverter systems --- for MHD power stations 21 p0106 A79-16486

Solar-cell panel simulator 22 p0265 A79-23867

**INVERTERS**

Inverter systems --- for MHD power stations 21 p0106 A79-16486

**INVESTMENTS**

Industrialization study --- impact of government incentives and barriers on decision making in the industrial production of photovoltaics [NASA-CR-157953] 21 p0200 N79-12970

**INVISCID FLOW**

A two dimensional vortex sheet model of a Savonius Rotor 22 p0278 A79-26178

Two-dimensional analysis of vertical axis windmills 22 p0353 N79-19446

**IODIDES**

Engineering and bench-scale studies of the sulfur-iodine cycle at General Atomic 21 p0015 A79-10127

**IODINE**

The thermochemical decomposition of water using bromine and iodine 22 p0238 A79-20770

**ION ACCELERATORS**

Superconducting magnets - Present status and problems 22 p0311 A79-31009

Pulsed-power research and development in the USSR [AD-A056635] 21 p0193 N79-11859

**ION BEAMS**

Heavy-ion beam inertial-confinement fusion 21 p0054 A79-13448

Generation and applications of high power ion beams to fusion research 21 p0070 A79-14466

Effect of electrode shielding on beamlet-beamlet interaction in multiaperture sources 21 p0154 A79-18481

Microstability of a focused ion beam propagating through a z-pinch plasma 22 p0270 A79-24817

Relaxation of a fast ion beam in a tokamak plasma 22 p0324 A79-31760

Pulsed-power research and development in the USSR [AD-A056635] 21 p0193 N79-11859

**ION CURRENTS**

Preparation and ionic conductivity of H3O<sup>+</sup>/beta alumina --- for hydrogen-oxygen fuel cells 21 p0040 A79-11821

Characterization of electron and ion current flow in very large aspect-ratio terawatt diodes employing heated and unheated anodes 21 p0154 A79-18480

**ION CYCLOTRON RADIATION**

Present status of two R.F. heating schemes - I.C.R.H. and L.H.R.H. --- Ion Cyclotron Resonant Heating and Lower-Hybrid Resonant Heating of plasma 21 p0071 A79-14467

Cyclotron-wave spectrum in a plasma with two ion species 22 p0245 A79-21443

Magneto-acoustic resonance heating in the ion-cyclotron frequency domain --- of tokamak plasmas 22 p0271 A79-24866

**ION DISTRIBUTION**

Auxiliary heating in breakeven tokamaks 21 p0079 A79-14792

**ION INJECTION**

Magnetic multipole line-cusp plasma generator for neutral beam injectors 22 p0238 A79-20746

**ION MOTION**

Parametric decay of lower hybrid waves in a plasma - Effect of ion nonlinearity --- in tokamaks 22 p0269 A79-24814

**ION PROPULSION**

Changes in the terrestrial atmosphere-ionosphere-magnetosphere system due to ion propulsion for solar power satellite placement [NASA-TN-79719] 22 p0345 N79-17897

Earth orbital assessment of solar electric and solar sail propulsion systems [NASA-CR-158167] 22 p0345 N79-17898

Closed Loop solar array-ion thruster system with power control circuitry [NASA-CASE-LEW-12780-1] 22 p0357 N79-20179

**ION SOURCES**

The advanced thermionic converter with microwave power as an auxiliary ionization source 21 p0153 A79-18470

Effect of electrode shielding on beamlet-beamlet interaction in multiaperture sources 21 p0154 A79-18481

**ION TEMPERATURE**

On the ion energy balance in TFR with and without neutral injection heating 21 p0069 A79-14452

Properties of the plasma ions and the particle lifetime in ohmic heating in the L-2 stellarator 22 p0244 A79-21428

Recombination-induced neutral-particle flux in tokamaks 22 p0291 A79-27877

**IONIC REACTIONS**

Space-dependent thermal stability of reacting tokamak plasmas 22 p0253 A79-22242

## IONIC WAVES

### IONIC WAVES

- Parametric decay of lower hybrid waves in a plasma  
- Effect of ion nonlinearity --- in tokamaks  
22 p0269 A79-24814

### IONIZATION

- Contribution to the theory of the pulsed mode of operation of the thermionic energy converter. II  
22 p0246 A79-21542

### IONIZED GASES

- 'Local' breakdown criterion in highly ionized gas flow  
21 p0049 A79-12683

### IONIZERS

- Ionizing seed --- for open cycle MHD power generation  
21 p0106 A79-16490

### IONOSPHERE

- Changes in the terrestrial atmosphere-ionosphere-magnetosphere system due to ion propulsion for solar power satellite placement  
[NASA-TM-79719]  
22 p0345 A79-17897

### IONOSPHERIC PROPAGATION

- Solar Power Satellite (SPS) pilot beam and communication link subsystem investigation study, phase 1 --- ionospheric propagation, radio frequency interference, and microwave transmission  
[NASA-CR-161161]  
22 p0345 A79-17896

### IRAN

- Computer simulation of the performance of a solar pond in the southern part of Iran  
21 p0133 A79-17432
- Solar thermal electrical power plants for Iran  
22 p0295 A79-28352

### IRAQ

- Availability of solar energy at Baghdad, Iraq - Performance and design data for flat plate collectors  
21 p0133 A79-17428

### IRON

- Goesbauer spectroscopy of iron in coal and coal hydrogenation products  
22 p0282 A79-26464
- Discharge characteristics of a soluble iron-titanium battery system  
22 p0286 A79-26996
- Supply of reactants for Redox bulk energy storage systems  
[NASA-TM-78995]  
21 p0183 A79-11479
- Design and cost study of a nickel-iron oxide battery for electric vehicles. Volume 2: Public report  
[ANL-K-3723-VOL-1]  
21 p0222 A79-14579

### IRON ALLOYS

- New alloy systems for hydrogen storage  
21 p0038 A79-11806
- The metallurgy and production of rechargeable hydrides --- for hydrogen storage  
22 p0250 A79-21703
- The iron-titanium - hydrogen system: A transmission electron microscope /TEM/ study  
22 p0285 A79-26947

### IRON CHLORIDES

- Problems around Fe-Cl cycles --- thermochemical decomposition of water hydrogen production  
22 p0238 A79-20771

### IRON COMPOUNDS

- Calcium/iron sulfide secondary cells  
21 p0041 A79-11835
- The use of FeTi-hydride for production and storage of suprapure hydrogen  
22 p0250 A79-21700

### IRON OXIDES

- Iron oxide semiconductor electrodes in photoassisted electrolysis of water  
21 p0037 A79-11781

### IRRADIANCE

- Irradiances on inclined surfaces --- from solar and sky radiation and earth albedo  
21 p0055 A79-13624
- Total solar irradiance at Table Mtn, California 1926-77  
21 p0067 A79-14269
- Proposal for efficient appreciation of solar thermal absorptive materials by high irradiance solar simulator  
21 p0130 A79-17406

## SUBJECT INDEX

### IRRADIATION

- Results of measurements of solar radiation on surfaces of different orientations  
21 p0055 A79-13622
- The use of a sort of slide rule for the quick determination of solar irradiation of surfaces and through double glazing of arbitrary orientation and different inclination  
21 p0055 A79-13625

### IRREVERSIBLE PROCESSES

- On an irreversible thermodynamic analysis of thermoelectric devices  
22 p0260 A79-23609

### IRRIGATION

- Solar energy installations for pumping irrigation water  
21 p0066 A79-14260
- Historical developments of the use of solar energy for pumping irrigation water  
21 p0076 A79-14762
- Basic technical and economical aspects of the use of solar energy for pumping irrigation water  
21 p0076 A79-14763
- A comparison between sun and wind as energy sources in irrigation plants  
21 p0118 A79-17295
- 25 kilowatt photovoltaic powered irrigation and grain drying experiment  
21 p0143 A79-17519
- Solar irrigation program status  
21 p0143 A79-17520
- The development of a 37 kW solar-powered irrigation system  
21 p0144 A79-17525
- Solar powered irrigation: Present status and future outlook  
[SAND-78-0016C]  
21 p0175 A79-10539
- Solar irrigation program plan: Second revision  
[SAND-78-0308-REV]  
21 p0187 A79-11525
- Solar Irrigation Program Data Base Management System (SIPDBMS)  
[SAND-78-0641]  
21 p0209 A79-13532
- Solar irrigation program  
[SAND-78-0049]  
21 p0210 A79-13537
- Preliminary economic analysis of Solar Irrigation Systems (SIS) for selected locations  
[SAND-77-1403]  
21 p0220 A79-14566
- The ground water and energy supply situation for Great Plains irrigation  
[PB-286002/1]  
21 p0222 A79-14586
- Applying NASA remote sensing data to geologically related regional planning problems in Tennessee  
[E79-10095]  
22 p0339 A79-17289
- Resource analysis: Water and energy as linked resources  
[PB-288046/6]  
22 p0349 A79-18463

### ISOTHERMAL PROCESSES

- The Pseudo Stirling cycle - A suitable performance criterion  
21 p0023 A79-10196
- Balanced compounding of Stirling machines  
21 p0024 A79-10200

### ISOTOPE SEPARATION

- A collisional plasma rotating between two cylinders  
21 p0049 A79-12694

### ISOTOPES

- Mini-BRU/BIPS 1300 watt (sub) dynamic power conversion system development: Executive summary  
[NASA-CR-159440]  
21 p0173 A79-10526

### ITALY

- Shallow magmatic reservoirs as heat source of geothermal systems - Preliminary interpretation of data available for the Neapolitan active volcanic areas  
21 p0075 A79-14727
- Magnetotelluric and geoelectric measurements for geothermal exploration in the Phlegraean Fields /preliminary results/  
21 p0075 A79-14732
- Study of the applicability of the geochemistry of gases in geothermal prospecting  
21 p0075 A79-14736
- Suggestions for a geochemical prospecting of geothermal systems - A first survey of the Italian thermal springs  
21 p0075 A79-14737

# SUBJECT INDEX

# KINETICS

J

## JAPAN

Energy use in Japan and the United States  
[BNL-23101] 21 p0221 N79-14578

## JET AIRCRAFT

Flying angle of attack 21 p0048 A79-12384

## JET ENGINE FUELS

Jet fuels from shale oil - A near term technology 21 p0005 A79-10045

Alternative aircraft fuels 21 p0033 A79-10824

Some aspects of aircraft jet engine fuels 21 p0035 A79-11368

Alternative aviation turbine fuels 21 p0047 A79-12378

Future fuels in gas turbine engines 21 p0051 A79-12979

Hydrogen enrichment for low-emission jet combustion 22 p0244 A79-21347

Shale oil - The answer to the jet fuel availability question 22 p0274 A79-25900

[SAE PAPER 781027] 22 p0274 A79-25900

Effect of broadened-specification fuels on aircraft engines and fuel systems 22 p0300 A79-29383

[AIAA 79-7008] 22 p0300 A79-29383

Testing to assess the affect of degraded fuel specifications on the cold start ability of a T63-A-700 engine 22 p0300 A79-29384

[AIAA 79-7009] 22 p0300 A79-29384

High-freezing-point fuels used for aviation turbine engines 22 p0309 A79-30555

[ASME PAPER 79-GT-141] 22 p0309 A79-30555

The influence of overall equivalence ratio and degree of stratification on the fuel consumption and emissions of a prechamber, stratified-charge engine 22 p0315 A79-31375

[SAE PAPER 790438] 22 p0315 A79-31375

Prospects for reducing the fuel consumption of civil aircraft 22 p0325 A79-31911

Aviation fuels from coal 22 p0325 A79-31913

Aircraft Engine Future Fuels and Energy Conservation 21 p0201 N79-13192

[AGARD-LS-96] 21 p0201 N79-13192

Future fuels for aviation 21 p0201 N79-13193

Future aviation fuels fuel suppliers views 21 p0202 N79-13194

The role of fundamental combustion in the future aviation fuels program --- carbon formation in gas turbine primary zones 21 p0202 N79-13195

Characteristics and combustion of future hydrocarbon fuels 21 p0202 N79-13196

Impact of future fuel properties on aircraft engines and fuel systems 21 p0202 N79-13197

Evaluation of future jet fuel combustion characteristics 21 p0216 N79-14231

[AD-A060218] 21 p0216 N79-14231

Naval Air Systems Command-Naval Research Laboratory Workshop on Basic Research Needs for Synthetic Hydrocarbon Jet Aircraft Fuels 21 p0216 N79-14235

[AD-A060081] 21 p0216 N79-14235

Behavior of nonmetallic materials in shale oil derived jet fuels and in high aromatic and high sulfur petroleum fuels --- compatibility of aircraft materials to fuels 21 p0226 N79-15203

[AD-A060322] 21 p0226 N79-15203

Effect of broadened-specification fuels on aircraft engines and fuel systems 22 p0330 N79-16136

[NASA-TN-79086] 22 p0330 N79-16136

Parametric performance of a turbojet engine combustor using jet A and A diesel fuel 22 p0357 N79-20114

[NASA-TN-79089] 22 p0357 N79-20114

## JET IMPINGEMENT

Jet impingement solar air heater 21 p0061 A79-13861

[AIAA PAPER 78-1760] 21 p0061 A79-13861

## JET NOZZLES

Flow modeling of an atmospheric pressure, entrained-type coal gasifier 22 p0280 A79-26186

## JET PUMPS

Design of a freon jet pump for use in a solar cooling system 21 p0164 A79-19847

[ASME PAPER 78-WA/SOL-15] 21 p0164 A79-19847

## JETTISONING

Drop formation, evaporation modelling and environmental assessment of JP-4 fuel jettisoned from aircraft 21 p0157 A79-19585

[AIAA PAPER 79-0186] 21 p0157 A79-19585

## JIGS

Solar cell module assembly jig 22 p0353 N79-19447

[NASA-CASE-IGS-00829-1] 22 p0353 N79-19447

## JP-4 JET FUEL

Drop formation, evaporation modelling and environmental assessment of JP-4 fuel jettisoned from aircraft 21 p0157 A79-19585

[AIAA PAPER 79-0186] 21 p0157 A79-19585

## JP-5 JET FUEL

Effects of fuel properties on soot formation in turbine combustion 22 p0274 A79-25899

[SAE PAPER 781026] 22 p0274 A79-25899

Evaluation of the application of some gas chromatographic methods for the determination of properties of synthetic fuels 22 p0274 A79-25917

Further studies of fuels from alternate sources: 22 p0201 N79-13182

Fire extinguishment experiments with JP-5 jet turbine fuel derived from shale 21 p0201 N79-13182

[AD-A058586] 21 p0201 N79-13182

## JUNCTION DIODES

Characterization of electron and ion current flow in very large aspect-ratio terawatt diodes employing heated and unheated anodes 21 p0154 A79-18480

21 p0154 A79-18480

## JUPITER PROJECT

Selenide technology evaluation program at JPL 21 p0026 A79-10222

21 p0026 A79-10222

K

## KENTUCKY

Solar system installation at Louisville, Kentucky 21 p0172 N79-10518

[NASA-CR-150814] 21 p0172 N79-10518

A Kentucky energy resource utilization program 21 p0198 N79-12574

[PB-283796/1] 21 p0198 N79-12574

## KEROGEN

Organic geochemical studies on kerogen precursors in recently deposited algal mats and oozes 21 p0031 A79-10419

Combustion rates for oil shale carbonaceous residue 21 p0032 A79-10522

21 p0032 A79-10522

## KEROSENE

Selection of a characteristic quantity defining the self-ignition of a fuel in a stream 21 p0114 A79-16786

Laser aircraft --- using kerosene 22 p0284 A79-26597

Toxic component concentration in kerosene-air mixture combustion products 22 p0291 A79-27733

The influence of fuel composition on smoke emission from gas-turbine-type combustors - Effect of combustor design and operating conditions 22 p0323 A79-31510

22 p0323 A79-31510

## KEVLAR (TRADEMARK)

Composite material flywheel for the electric-powered passenger vehicle 22 p0240 A79-20842

A status of the 'Alpha-ply' composite flywheel concept development 22 p0241 A79-20843

Comparative properties of fiber composites for energy-storage flywheels part A. Evaluation of fibers for flywheel rotors --- Kevlar/epoxy and glass/epoxy composites 21 p0215 N79-14165

[UCRL-80116-PT-A] 21 p0215 N79-14165

## KINETIC ENERGY

Mechanical energy storage system for a 10 kWe solar power pack 21 p0121 A79-17329

21 p0121 A79-17329

## KINETIC EQUATIONS

Heat transport near the wall of a tokamak reactor 22 p0324 A79-31764

22 p0324 A79-31764

## KINETICS

Kinetic modeling of pyrolysis and hydrogasification of carbonaceous materials --- converting wood waste char to clean fuels 21 p0179 N79-11150

21 p0179 N79-11150

## KOREA

## KOREA

- Some experimental investigations on solar space heating in Korea 21 p0138 A79-17470

## L

## L-1011 AIRCRAFT

- Fuel conservative subsonic transport --- control surfaces activated by computers 22 p0337 N79-16874

## LABOR

- Assessment of economic factors affecting the satellite power system. Volume 1: System cost factors [NASA-CR-161185] 22 p0368 N79-21551

## LAKES

- Reservoir ecosystems and western coal development in the upper Missouri River Basin [PB-287363/6] 22 p0339 N79-17309

## LAMINAR FLOW

- Buoyancy effects in a solar regenerator --- for air dehumidifier absorbent solutions 22 p0262 A79-23752  
MHD generator duct flow with cross stream dependent fluid properties 22 p0336 N79-16668

## LAMINATES

- The thermomechanical behavior of polyvinyl butyral film and its effect on focal stability of a solar mirror-laminate 22 p0239 A79-20824

## LAND USE

- Energy availabilities for state and local development: Projected energy patterns for 1980 and 1985 [ORNL/TM-5890/54] 21 p0186 N79-11511  
Application of LANDSAT data and digital image processing --- Ruhr Valley, Germany [E79-10102] 22 p0339 N79-17291  
Atlas of western surface-mined lands: Coal, uranium, and phosphate [PB-287846/0] 22 p0340 N79-17311

## LANDSAT SATELLITES

- Landsat - Developing techniques and applications in mineral and petroleum exploration 21 p0111 A79-16725

## LANTHANUM COMPOUNDS

- Hydrogen storage by LaNi5 - Fundamentals and applications 21 p0038 A79-11803  
Localization and diffusion of hydrogen in lanthanum-nickel compounds 22 p0248 A79-21682  
Some applications of LaNi5-type hydrides --- using reversible reaction with hydrogen working fluid for heat storage 22 p0249 A79-21694  
Metal hydride electrodes for electrochemical energy storage 22 p0249 A79-21695

## LARGE SPACE STRUCTURES

- The design and evaluation of a 5 GW Gallias solar power satellite /SPS/ 21 p0002 A79-10024  
Space platforms for building large space structures 21 p0032 A79-10511  
On-orbit fabrication and assembly of large space structural subsystems [IAP PAPER 78-192] 21 p0035 A79-11288  
New design verification aspects of large flexible solar arrays [IAP PAPER 78-217] 21 p0035 A79-11298  
Advanced composites - Future space applications 21 p0086 A79-15504  
A technology program for large area space systems 21 p0100 A79-16145  
Overview of future programs - USA --- manned orbital space missions 21 p0116 A79-17275  
A development strategy for the solar power satellite [AAS PAPER 78-154] 22 p0243 A79-21266  
Space will be the next big construction site 22 p0268 A79-24450  
Solar power satellite 22 p0287 A79-27375

## SUBJECT INDEX

- Future large space systems opportunities: A case for space-to-space power? --- spacecraft power supplies microwave and laser transmission 21 p0169 N79-10095

## LASER APPLICATIONS

- Optical evaluation techniques for reflecting solar concentrators 21 p0043 A79-11971  
Five MW solar thermal test facility heliostat focus and alignment system 21 p0043 A79-11972  
Facility with sectioned photoreceiver and laser radiator for determining solar radiation concentrator accuracy characteristics 21 p0054 A79-13292  
Radiation energy conversion in space; Conference, 3rd, NASA Ames Research Center, Moffett Field, Calif., January 26-28, 1978, Technical Papers 21 p0107 A79-16601  
Laser aircraft propulsion 21 p0109 A79-16618  
Laser-powered aircraft and rocket systems with laser energy relay units 21 p0109 A79-16619  
The use of lasers for the transmission of power 21 p0109 A79-16621  
New candidate lasers for power beaming and discussion of their applications --- solar powered space lasers 21 p0110 A79-16622  
Systems efficiency and specific mass estimates for direct and indirect solar-pumped closed-cycle high-energy lasers in space 21 p0110 A79-16623  
Quasi-isentropic laser engines 21 p0111 A79-16632  
Status and summary of laser energy conversion --- for space power transmission systems 21 p0111 A79-16635  
Laser ray trace tester for parabolic trough solar collectors 21 p0144 A79-17619  
Laser aircraft --- using kerosene 22 p0284 A79-26597  
Solar power satellites - The laser option 22 p0284 A79-26599  
Future large space systems opportunities: A case for space-to-space power? --- spacecraft power supplies microwave and laser transmission 21 p0169 N79-10095  
Sensitivity of slope measurements on parabolic solar mirrors to positioning and alignment of the laser scanner [SAND-78-0700] 21 p0185 N79-11496

## LASER DAMAGE

- Techniques for preventing damage to high power laser components --- Shiva laser fusion experiments 21 p0083 A79-15145  
Prepulse damage to targets and alignment verification 22 p0258 A79-23027

## LASER FUSION

- Overview of inertial confinement fusion reactor designs 21 p0018 A79-10149  
CO2-laser fusion 21 p0018 A79-10150  
Commercial applications of thermionic conversion using a fusion reactor energy source - A preliminary assessment 21 p0026 A79-10219  
Electric power from laser fusion - The RYLIFE concept 21 p0030 A79-10249  
The laser fusion scientific feasibility experiment 21 p0030 A79-10250  
Hybrid reactor based on laser-induced thermonuclear fusion 21 p0032 A79-10658  
Progress in laser-fusion research 21 p0070 A79-14464  
DOE programs in material development for fusion laser systems 21 p0082 A79-15137  
Requirements and new materials for fusion laser systems 21 p0082 A79-15138



# SUBJECT INDEX

# LEACHING

- Review of theories for predicting n2 in glasses and crystals --- refractive index of fusion laser materials 21 p0083 A79-15139
- Performance of the short-pulse oscillators for Argus and Shiva 21 p0083 A79-15171
- A new method for producing cryogenic laser fusion targets 21 p0085 A79-15332
- Development of cryogenic targets for laser fusion 21 p0085 A79-15333
- Cryogenic pellets for laser-fusion research - Theoretical and practical considerations 21 p0085 A79-15334
- Point-contact conduction-cooling technique and apparatus for cryogenic laser fusion pellets 21 p0085 A79-15335
- Self-adjusting laser-target system for laser fusion 21 p0086 A79-15625
- Stimulated Raman scatter in laser fusion target chambers 21 p0155 A79-18794
- An overview of design space for small fusion targets 22 p0253 A79-22241
- Prepulse damage to targets and alignment verification 22 p0258 A79-23027
- Fuel content characterization and pressure retention measurements of DT-filled laser fusion microballoon targets 22 p0258 A79-23034
- Diagnostics of Shiva Nova high-yield thermonuclear events --- in laser fusion 22 p0285 A79-26747
- Pellet X-ray spectra for laser fusion reactor designs 22 p0291 A79-27878
- Self-consistent analysis of alpha-particle heating of a fast-solenoid plasma --- in laser fusion 22 p0291 A79-27879
- Two-dimensional monochromatic X-ray imaging of laser-produced plasmas --- during implosions for laser fusion 22 p0296 A79-28366
- Civilian applications of laser fusion [UCRL-52389] 21 p0195 A79-12439
- LASER HEATING**
  - The LASER /laser-ash/ particulate fragmentation removal concept for coal fired turbine power plants 21 p0009 A79-10078
  - The TELEC - A plasma type of direct energy converter --- Thermo-Electronic Laser Energy Converter for electric power generation 21 p0110 A79-16629
  - Energy exchanger technology applied to laser heated engines 21 p0110 A79-16631
  - Quasi-isentropic laser engines 21 p0111 A79-16632
  - Analysis of a cylindrical imploding shock wave 21 p0155 A79-18846
- LASER MATERIALS**
  - DOE programs in material development for fusion laser systems 21 p0082 A79-15137
  - Requirements and new materials for fusion laser systems 21 p0082 A79-15138
  - Review of theories for predicting n2 in glasses and crystals --- refractive index of fusion laser materials 21 p0083 A79-15139
  - A survey of laser glasses --- for fusion studies 21 p0083 A79-15140
  - Mechanical deflection analysis of diamond turned reflective optics --- for laser fusion 21 p0083 A79-15143
  - Techniques for preventing damage to high power laser components --- Shiva laser fusion experiments 21 p0083 A79-15145
- LASER MODE LOCKING**
  - Performance of the short-pulse oscillators for Argus and Shiva 21 p0083 A79-15171
- LASER OUTPUTS**
  - Progress in nuclear-pumped lasers 21 p0110 A79-16627
- LASER PLASMA INTERACTIONS**
  - Prepulse damage to targets and alignment verification 22 p0258 A79-23027
- LASER PLASMAS**
  - Progress in laser-fusion research 21 p0070 A79-14464
  - Self-adjusting laser-target system for laser fusion 21 p0086 A79-15625
  - Measurements of compressed core density of laser-imploded targets by x-ray continuum-edge shift 21 p0154 A79-18479
  - Stimulated Raman scatter in laser fusion target chambers 21 p0155 A79-18794
  - Diagnostics of Shiva Nova high-yield thermonuclear events --- in laser fusion 22 p0285 A79-26747
  - Two-dimensional monochromatic X-ray imaging of laser-produced plasmas --- during implosions for laser fusion 22 p0296 A79-28366
  - Effects of nonlinear decay of backscattered light on the anomalous reflectivity --- in laser plasmas 22 p0310 A79-30742
- LASER SPECTROSCOPY**
  - Laser measurements of the radial profiles of the electron temperature and density in the FT-1 tokamak 22 p0244 A79-21430
- LASER TARGETS**
  - Self-adjusting laser-target system for laser fusion 21 p0086 A79-15625
  - Measurements of compressed core density of laser-imploded targets by x-ray continuum-edge shift 21 p0154 A79-18479
  - Diagnostics of Shiva Nova high-yield thermonuclear events --- in laser fusion 22 p0285 A79-26747
- LASERS**
  - Laser power conversion system analysis, volume 1 [NASA-CR-159523-VOL-1] 22 p0366 A79-21334
  - Laser power conversion system analysis, volume 2 [NASA-CR-159523-VOL-2] 22 p0366 A79-21335
- LASING**
  - DOE programs in material development for fusion laser systems 21 p0082 A79-15137
  - Requirements and new materials for fusion laser systems 21 p0082 A79-15138
  - A survey of laser glasses --- for fusion studies 21 p0083 A79-15140
  - A new concept for solar pumped lasers 21 p0110 A79-16624
  - Direct conversion of solar energy into laser radiation 22 p0311 A79-31086
- LATTICE PARAMETERS**
  - A new rationale for the hysteresis effects observed in metal-hydrogen systems 22 p0250 A79-21704
- LAW (JURISPRUDENCE)**
  - The need for closed service areas in a supply economy based on line networks --- for German gas and electric utilities 21 p0168 A79-20447
  - National Aeronautics and Space Act of 1958, as amended, and related legislation [GPO-34-175] 21 p0214 A79-13932
- LAYOUTS**
  - Layout and design characteristics of MBE power stations 21 p0105 A79-16481
- LEACHING**
  - Applicability of the Meyers process for desulfurization of U.S. coal - A survey of 35 coals --- through chemical leaching 21 p0044 A79-12117
  - Coal desulfurization test plant status - July 1977 --- utilizing Meyers leach process 21 p0044 A79-12118

# LEAD (METAL)

# SUBJECT INDEX

## LEAD (METAL)

Motor vehicle lead emissions in the United States  
- An analysis of important determinants,  
geographic patterns and future trends  
21 p0113 A79-16745

## LEAD ACID BATTERIES

Rapid, efficient charging of lead-acid and  
nickel-zinc traction cells --- for electric  
vehicles  
21 p0009 A79-10084

Response of lead-acid batteries to  
chopper-controlled discharge --- for electric  
vehicles  
21 p0011 A79-10097

Effect of electrolyte impurity on the  
electrochemical performance of the  
lead/tetrafluoroboric acid/lead dioxide cell  
22 p0246 A79-21485

Prospects for improvements in lead-acid batteries  
--- for electric vehicles  
22 p0300 A79-29488

Electric vehicle battery development  
[SAE PAPER 790158]  
22 p0314 A79-31363

A high energy tubular battery for a 1800 kg  
payload electric delivery van  
[SAE PAPER 790162]  
22 p0315 A79-31367

A state of charge monitor for sealed lead-acid cells  
[ATR-78 (8114)-2]  
21 p0220 A79-14558

Lead-acid battery: An evaluation of  
commercialization strategies  
[ATR-7593]  
21 p0220 A79-14565

## LEAD COMPOUNDS

The influence of lead compounds on automotive  
exhaust catalysts  
21 p0116 A79-17253

## LEAKAGE

Measured effects of flow leakage on the  
performance of the GT-225 automotive gas turbine  
engine  
[ASME PAPER 79-GT-3]  
22 p0306 A79-30502

## LEGAL LIABILITY

Legal barriers to solar heating and cooling of  
buildings  
[BCP/M2528-1]  
21 p0209 A79-13534

## LENS DESIGN

Solar concentrators --- using cheap refractive  
lenses  
21 p0136 A79-17455

Design, construction and performance of Fresnel  
lens for solar energy collection  
21 p0136 A79-17456

Efficient Fresnel lens for solar concentration  
22 p0285 A79-26816

## LIBRATIONAL MOTION

Translational attitude dynamics of satellites with  
deploying flexible appendages  
21 p0047 A79-12325

## LIFE (DURABILITY)

Design features of the TDRSS solar array ---  
Tracking and Data Relay Satellites  
21 p0002 A79-10019

Recent advances in electrocatalysis and their  
implications for fuel cells  
21 p0038 A79-11807

## LIFE CYCLE COSTS

User experience with on-road electric vehicles in  
the U.S.A. and Canada  
21 p0009 A79-10080

Nickel-zinc vs. silver-zinc battery - A  
comparative study of baseline characteristics  
21 p0009 A79-10083

Collection of data for estimating the probable  
life cycle costs of solar energy systems  
21 p0087 A79-15828

Economic evaluation and optimization of solar  
heating systems  
21 p0118 A79-17293

Some aspects towards the performance evaluation  
and ensuing design components of solar collector  
systems  
21 p0130 A79-17404

Study of flywheel energy storage Volume 1:  
Executive summary  
[PB-282652/7]  
21 p0176 A79-10555

Study of flywheel energy storage. Volume 2:  
Systems analysis  
[PB-282653/5]  
21 p0176 A79-10556

Study of flywheel energy storage. Volume 3:  
System mechanization  
[PB-282654/3]  
21 p0177 A79-10557

Study of flywheel energy storage. Volume 4:  
Life-cycle costs  
[PB-282655/0]  
21 p0177 A79-10558

Sodium-antimony trichloride battery development  
program for load leveling  
[EPRI-EH-751]  
21 p0186 A79-11501

Results of systems analysis --- effectiveness of  
integrated solar energy systems  
21 p0218 A79-14534

Life-cycle costing. A guide for selecting energy  
conservation projects for public buildings ---  
computing the cost effectiveness of retrofitting  
and new buildings  
[PB-287804/9]  
22 p0345 A79-17744

## LIFT

An inverse problem of vertical-axis wind turbines  
22 p0239 A79-20800

## LIFT AUGMENTATION

Diffuser designs for improved wind energy conversion  
22 p0279 A79-26182

## LIGHT AIRCRAFT

Turbine engines in light aircraft  
21 p0047 A79-12380

## LIGHT BEAMS

New candidate lasers for power beaming and  
discussion of their applications --- solar  
powered space lasers  
21 p0110 A79-16622

## LIGHT SCATTERING

Self-adjusting laser-target system for laser fusion  
21 p0086 A79-15625

Stimulated Raman scatter in laser fusion target  
chambers  
21 p0155 A79-18794

Effects of nonlinear decay of backscattered light  
on the anomalous reflectivity --- in laser plasmas  
22 p0310 A79-30742

## LIGHT TRANSMISSION

Laser-powered aircraft and rocket systems with  
laser energy relay units  
21 p0109 A79-16619

The use of lasers for the transmission of power  
21 p0109 A79-16621

## LIGHT WATER BREEDER REACTORS

Exploring future energy options - An economic  
analysis  
21 p0068 A79-14324

## LIGHTING EQUIPMENT

Market definition studies for photovoltaic highway  
applications  
[NASA-CR-159477]  
22 p0354 A79-19451

## LIGHTNING

Lightning protection for the vertical axis wind  
turbine  
[SAND-77-1241]  
21 p0221 A79-14567

## LIGNIN

Gasification of raw lignite in the tube-furnace  
gasifier  
22 p0310 A79-30996

Texas lignite: Environmental planning opportunities  
[PB-286870/1]  
21 p0231 A79-15438

## LIMESTONE

Factors limiting limestone utilization efficiency  
in fluidized-bed combustors --- in determining  
sulfur dioxide emission level  
21 p0008 A79-10069

Potential agricultural uses of fluidized bed  
combustion waste  
21 p0064 A79-14108

Limestone SO<sub>2</sub> reactivity and causes for reactivity  
loss during multi cycle utilization  
21 p0065 A79-14121

## LIMITER CIRCUITS

The effect of limiters and current profile on  
elliptic free-boundary MHD equilibria  
22 p0291 A79-27881

## LIMNOLOGY

Reservoir ecosystems and western coal development  
in the upper Missouri River Basin  
[PB-287363/6]  
22 p0339 A79-17309

## LINEAR CIRCUITS

Limit of formation of counterflows in plane linear  
induction MHD machines  
22 p0298 A79-29288

# SUBJECT INDEX

# LITHIUM COMPOUNDS

## LINEAR EQUATIONS

Equations of a conduction MHD ejector  
22 p0298 A79-29289

## LINEAR PROGRAMMING

The Brookhaven buildings energy conservation optimization model  
[BNL-50828] 22 p0370 N79-21564

## LININGS

Compact fusion reactors using controlled imploding liners  
21 p0018 A79-10151  
A calculation of linear magnetic liner fusion reactor performance  
21 p0018 A79-10153

## LIQUEFIED NATURAL GAS

Detection of internal defects in a liquid natural gas tank by use of infrared thermography  
21 p0048 A79-12507  
Liquid mixture excess volumes and total vapor pressures using a magnetic suspension densimeter with compositions determined by chromatographic analysis Methane plus ethane  
21 p0085 A79-15328

Mathematical models of direct initiation of unconfined gas phase detonations --- hazards of LNG/air clouds from spills  
[AIAA PAPER 79-0289] 21 p0157 A79-19649

The utilization of LH2 and LNG cold for generation of electric power by a cryogenic-type Stirling engine  
22 p0311 A79-31020

Liquefied natural gas wind tunnel simulation and instrumentation assessments  
[SAN-W1364-01] 21 p0195 N79-12256

The use of liquid natural gas as heat sink for power cycles  
22 p0332 N79-16262

Liquefied natural gas safety research overview  
[AD-A063714] 22 p0365 N79-21233

## LIQUID AMMONIA

Theoretical basis and design for a residential size solar powered ammonia/water absorption air conditioning system  
21 p0139 A79-17479

Solar ammonia-water absorption system for cold storage application  
21 p0143 A79-17521

## LIQUID COOLING

Drag reduction by cooling in hydrogen fueled aircraft  
21 p0165 A79-20084

The Alcator liquid nitrogen-cooled tokamaks  
22 p0290 A79-27668

Water-cooled gas turbine technology development - Fuels flexibility  
[ASME PAPER 79-GT-72] 22 p0307 A79-30536

## LIQUID FLOW

Liquid desiccant solar air conditioner and energy storage system  
21 p0021 A79-10176

A practical electrochemical transport equation for non-dilute solutions --- for energy storage application  
21 p0041 A79-11841

Optimizing solar energy systems using continuous flow control  
21 p0138 A79-17477

## LIQUID HYDROGEN

Alternate aircraft fuels prospects and operational implications  
21 p0066 A79-14138

The potential of liquid hydrogen as a military aircraft fuel  
22 p0238 A79-20773

Cryohydrogen-fuel for tomorrow's commercial aircraft  
22 p0289 A79-27656

The utilization of LH2 and LNG cold for generation of electric power by a cryogenic-type Stirling engine  
22 p0311 A79-31020

Study of hydrogen recovery systems for gas vented while refueling liquid-hydrogen fueled aircraft  
[NASA-CR-158991] 22 p0346 N79-18057

## LIQUID LITHIUM

Lithium and potassium heat pipes for thermionic converters  
21 p0013 A79-10113

## LIQUID METALS

Liquid metal heat pipes for the central solar receiver  
21 p0014 A79-10114

A calculation of linear magnetic liner fusion reactor performance  
21 p0018 A79-10153

Liquid metal heat pipe performance in the presence of a transverse magnetic field --- for fusion reactors  
[ASME PAPER 78-ENAS-20] 21 p0048 A79-12569

The role of interfacial heat and mechanical energy transfers in a liquid-metal MHD generator  
[ASME PAPER 78-WA/HT-33] 21 p0161 A79-19814

Calculation and design of liquid-metal MHD induction machines --- Russian book  
22 p0286 A79-27302

An overview of liquid metal MHD --- for power generation  
22 p0289 A79-27660

## LIQUID NITROGEN

The Alcator liquid nitrogen-cooled tokamaks  
22 p0290 A79-27668

## LIQUID PHASES

Liquid-phase reactions of vaporizing hydrocarbon fuels  
21 p0052 A79-12987

Improved anodes for liquid hydrocarbon fuel cell  
[AD-A058456] 21 p0206 N79-13504

## LIQUID ROCKET PROPELLANTS

Feasibility of rocket propellant production on Mars  
21 p0047 A79-12324

## LIQUID-GAS MIXTURES

Mathematical models of direct initiation of unconfined gas phase detonations --- hazards of LNG/air clouds from spills  
[AIAA PAPER 79-0289] 21 p0157 A79-19649

Toxic component concentration in kerosene-air mixture combustion products  
22 p0291 A79-27733

## LIQUID-SOLID INTERFACES

Semiconductor liquid junction solar cells - Efficiency, electrochemical stability, and surface preparation  
21 p0037 A79-11783

## LIQUID-VAPOR EQUILIBRIUM

Phase equilibria in coal hydrogenation systems  
[PE-2334-6] 21 p0171 N79-10238

## LIQUID-VAPOR INTERFACES

The role of interfacial heat and mechanical energy transfers in a liquid-metal MHD generator  
[ASME PAPER 78-WA/HT-33] 21 p0161 A79-19814

Experimental study of the characteristics of heat and mass transfer in a two-component low-temperature heat pipe  
22 p0246 A79-21585

## LIQUIDS

A liquid solar energy storage tank model. I Formulation of a mathematical model  
22 p0267 A79-24314

## LITHIUM

Development and evaluation of a 600-kWh lithium-hydrogen peroxide reserve power system  
21 p0011 A79-10095

Electric power from laser fusion - The HYLIFE concept  
21 p0030 A79-10249

The secondary lithium electrode in non-aqueous electrolytes - Some problems, some solutions  
21 p0041 A79-11838

Silver selenate and silver tellurate as positive materials for lithium primary power sources  
22 p0245 A79-21484

On the possibility of using silver salts other than Ag2CrO4 in organic lithium cells  
22 p0246 A79-21491

Primary lithium battery technology and its application to NASA missions  
[NASA-CR-158229] 22 p0354 N79-19449

## LITHIUM COMPOUNDS

Performance predictions of a LiBr absorption air conditioner utilizing solar energy  
21 p0139 A79-17482

Integration of evacuated tubular solar collectors with lithium bromide absorption cooling systems  
21 p0139 A79-17483

# LITHIUM SULFUR BATTERIES

# SUBJECT INDEX

## LITHIUM SULFUR BATTERIES

Differential scanning calorimetry studies of possible explosion-causing mixtures in Li/SO<sub>2</sub> cells 22 p0246 A79-21487

Low voltage behavior of lithium/metal dichalcogenide topochemical cells 22 p0286 A79-26995

Discharge reaction mechanisms in Li/SOCl<sub>2</sub> cells 22 p0305 A79-30331

A lithium/dissolved sulfur battery with an organic electrolyte 22 p0305 A79-30332

Thermal management of the lithium/metal sulfide electric vehicle [SAE PAPER 790161] 22 p0315 A79-31366

**LOADING ROBERTS**

Field testing of 5-kW commercial wind generator with an automatic load-matching device for utilizing its output 21 p0143 A79-17515

**LOCOMOTIVES**

Wayside energy storage summary: Volume 1: Summary [DOT-TSC-PRA-79-7-1-VCL-1] 22 p0370 N79-21563

**LOGIC DESIGN**

Development of gas turbine performance seeking logic [ASME PAPER 78-GT-13] 21 p0031 A79-10257

**LOGISTICS MANAGEMENT**

The need for closed service areas in a supply economy based on line networks --- for German gas and electric utilities 21 p0168 A79-20447

**LONG TERM EFFECTS**

Asymptotic behaviour as a guide to the long term performance of solar water heating systems 21 p0041 A79-11872

Long-term average performance of the Sunpak evacuated-tube collector 21 p0089 A79-15854

**LORENTZ FORCE**

Effect of force field nonuniformity on flow in an MHD channel 21 p0101 A79-16365

**LOUISIANA**

An assessment of subsurface salt water disposal experience on the Texas and Louisiana Gulf coast for application to disposal of salt water from geopressured geothermal wells [NVO/1531-2] 22 p0366 N79-21523

**LOW COST**

Iron-air batteries for electric vehicles 21 p0011 A79-10094

Low-cost concept for energy supply from the wind 21 p0058 A79-13651

Potential for low cost, high efficiency solar cells using indium tin oxide on semiconductor /OSOS/ solar cells 21 p0122 A79-17338

Solar concentrators --- using cheap refractive lenses 21 p0136 A79-17455

An evaluation of the strategy of low cost horizontal axis windmills 21 p0143 A79-17517

General view of low cost solar cell development in Japan 21 p0149 A79-17997

Recent developments in low cost silicon solar cells for terrestrial applications --- sheet production methods 22 p0239 A79-20821

Wind-turbine-generator rotor-blade concepts with low-cost potential 22 p0240 A79-20828

Materials for low-cost solar cells 22 p0252 A79-22099

Encapsulant materials for \$2/watt terrestrial photovoltaic arrays 22 p0266 A79-24138

System designs for low cost-low ratio solar concentrators 22 p0293 A79-28142

Low cost thin-film CdS-based solar cells progress and promise [ASME PAPER 79-SOL-15] 22 p0309 A79-30549

Phase 1 of the automated array assembly task of the low cost silicon solar array project [NASA-CR-158120] 22 p0348 N79-18451

Automated array assembly, phase 2. Low-cost solar array project, task 4 [NASA-CR-158365] 22 p0358 N79-20481

Phase two of the array automated assembly task for the low cost solar array project [NASA-CR-158359] 22 p0359 N79-20484

Solar space heaters for low-income families [PB-289244/6] 22 p0363 N79-20526

A low cost high temperature sun tracking solar energy collector 22 p0366 N79-21390

**LOW TEMPERATURE**

Theoretical and experimental analysis of a latent heat storage system --- solar energy absorbers 21 p0121 A79-17323

A heat pipe collector for low temperatures 21 p0127 A79-17385

Experimental study of the characteristics of heat and mass transfer in a two-component low-temperature heat pipe 22 p0246 A79-21585

Current status and prospects for low-temperature solar energy 22 p0269 A79-24623

Superconductivity in antenna engineering 22 p0311 A79-31008

Low-temperature application of solar energy in South Africa 22 p0340 N79-17324

**LOW TEMPERATURE ENVIRONMENTS**

Experiments in solar space heating and cooling for moderately insulated regions 21 p0137 A79-17464

**LUBRICANTS**

High sulfur fuel effects in a two-cycle high speed army diesel engine [AD-A059534] 21 p0216 N79-14232

**LUBRICATING OILS**

US Army/Environmental Protection Agency re-refined engine oil program [AD-A056806] 21 p0171 N79-10216

**LUMINAIRES**

The optimum voltage for batteries used in standby lighting systems [ELL-RTS-11512] 22 p0347 N79-18439

**LUMINOUS INTENSITY**

Overview of novel photovoltaic conversion techniques at high intensity levels 21 p0108 A79-16610

**LUNAR BASES**

Energy conversion at a lunar polar site 21 p0108 A79-16607

## M

**MAGMA**

Shallow magmatic reservoirs as heat source of geothermal systems - Preliminary interpretation of data available for the Neapolitan active volcanic areas 21 p0075 A79-14727

**MAGNESIUM ALLOYS**

The storage and release of hydrogen from magnesium alloy hydrides for vehicular applications 22 p0249 A79-21688

Method of producing a p-type or n-type alloy for direct thermoelectric energy conversion 22 p0260 A79-23615

**MAGNET COILS**

A superconducting dipole magnet system for the MHD facility at Univ. of Tennessee Space Institute 21 p0017 A79-10140

Flywheel energy storage system for JT-60 toroidal field coil 21 p0112 A79-16729

Design of a D-shaped toroidal field coil 21 p0156 A79-19083

Design criteria for multilayer superconductive magnets 22 p0236 A79-20536

Superconducting energy storage magnets 22 p0236 A79-20537

Heat pulses required to quench a potted superconducting magnet 22 p0236 A79-20538

The role of the Large Coil Program in the development of superconducting magnets for fusion reactors 22 p0236 A79-20541

# SUBJECT INDEX

# MAGNETIC MIRRORS

- SLPX - Superconducting Long-Pulse Tokamak Experiment  
22 p0237 A79-20557  
Design and development of the US-TESPE toroidal coil  
22 p0311 A79-31014
- MAGNETIC ANOMALIES**  
Magnetotelluric and geoelectric measurements for  
geothermal exploration in the Phlegraean Fields  
/preliminary results/  
21 p0075 A79-14732
- MAGNETIC CIRCUITS**  
Superconducting magnets --- for MHD applications  
21 p0105 A79-16485
- MAGNETIC COILS**  
Conductor for LASL 10-MW hr superconducting energy  
storage coil  
21 p0085 A79-15309
- MAGNETIC CONTROL**  
A calculation of linear magnetic liner fusion  
reactor performance  
21 p0018 A79-10153  
Tokamak reactors for breakeven: A critical study  
of the near-term fusion reactor program --- Book  
21 p0077 A79-14776  
Magnetic divertors --- in large tokamak plasma  
confinement experiments  
21 p0078 A79-14781  
Fusion power by magnetic confinement - Program plan  
21 p0080 A79-14794  
Magnetically confined plasma solar collector ---  
satellite based system in space  
21 p0109 A79-16617
- MAGNETIC DIPOLES**  
A superconducting dipole magnet system for the MHD  
facility at Univ. of Tennessee Space Institute  
21 p0017 A79-10140  
Fabrication experiences and operating  
characteristics of the U.S. SCMS superconducting  
dipole magnet for MHD research  
21 p0084 A79-15304  
A superconducting dipole magnet for the UTSI MHD  
Facility  
22 p0235 A79-20533
- MAGNETIC EFFECTS**  
Desulfurization of coals by high-intensity  
high-gradient magnetic separation - Conceptual  
process design and cost estimation  
21 p0044 A79-12116  
Liquid metal heat pipe performance in the presence  
of a transverse magnetic field --- for fusion  
reactors  
[ASME PAPER 78-ENAS-20]  
21 p0048 A79-12569
- MAGNETIC FIELD CONFIGURATIONS**  
Heating and confinement in the CLEO stellarator  
21 p0070 A79-14459  
Magnetic divertors --- in large tokamak plasma  
confinement experiments  
21 p0078 A79-14781  
The 'PINTOR 1' design - A minimum  
size tokamak  
21 p0078 A79-14782  
SLPX - Superconducting Long-Pulse Tokamak Experiment  
22 p0237 A79-20557  
Effect of the magnetic configuration of the  
poloidal divertor on the plasma in the T-12  
finger-ring tokamak  
22 p0244 A79-21429  
Accounting for the effect of a yoke in an MHD  
linear induction machine by stipulating boundary  
conditions of a new kind  
22 p0247 A79-21627  
Minimum-average-B wells in linked magnetic mirror  
fields --- for plasma control in fusion reactors  
22 p0252 A79-22237  
Local theory of finite-beta, collisional drift modes  
--- plasma stability analysis  
22 p0253 A79-22244  
Wave reflection from the lower hybrid surface - A  
toroidal effect --- in tokamaks  
22 p0255 A79-22427  
Equilibrium relations in the presence of arbitrary  
plasma diffusion in axisymmetric configurations  
22 p0257 A79-22979  
Collisional transport --- of plasmas in plane and  
toroidal geometry  
22 p0257 A79-22980  
MHD stability for a spherator with a purely  
poloidal magnetic field  
22 p0271 A79-24863
- Macroscopic stability and beta limit in the ELMO  
Bumpy Torus  
22 p0291 A79-27876  
Theory of dissipative drift instabilities in  
sheared magnetic fields --- in confined toroidal  
plasmas  
22 p0292 A79-27884  
Design and development of the US-TESPE toroidal coil  
22 p0311 A79-31014  
MHD stability of Spheromak  
22 p0313 A79-31189  
Plasma behavior near the neutral line between  
parallel currents --- in planar zeta pinch  
22 p0324 A79-31754  
Dynamic stabilization of toroidal discharges in  
weak longitudinal magnetic fields  
22 p0324 A79-31766
- MAGNETIC FIELDS**  
Attenuating the transverse edge effect in MHD  
generators  
21 p0063 A79-13985  
Fast penetration of a magnetic field into a  
low-density plasma  
22 p0244 A79-21432  
Cyclotron-wave spectrum in a plasma with two ion  
species  
22 p0245 A79-21443  
Integral invariants and quasi-MHD nonlinear  
dissipation --- in magnetized toroidal plasmas  
22 p0270 A79-24862  
Electromechanical conversion of energy during the  
deceleration of a piston in a uniform magnetic  
field  
22 p0309 A79-30599
- MAGNETIC INDUCTION**  
Accounting for the effect of a yoke in an MHD  
linear induction machine by stipulating boundary  
conditions of a new kind  
22 p0247 A79-21627  
Calculation and design of liquid-metal MHD  
induction machines --- Russian book  
22 p0286 A79-27302  
Optimality criteria in the compensation of the  
longitudinal boundary effect in induction MHD  
machines  
22 p0298 A79-29277  
Two asymptotic solutions for analyzing the  
transverse edge effect in induction MHD machines  
22 p0298 A79-29287  
Limit of formation of counterflows in plane linear  
induction MHD machines  
22 p0298 A79-29288
- MAGNETIC LENSES**  
Generation and applications of high power ion  
beams to fusion research  
21 p0070 A79-14466
- MAGNETIC MIRRORS**  
The Mirror Fusion Test Facility /MFTF/  
21 p0018 A79-10147  
Mirror fusion reactors  
21 p0018 A79-10148  
The mirror machine program in the USA ---  
controlled fusion experiments and research  
facilities  
21 p0070 A79-14461  
Fusion power by magnetic confinement - Program plan  
21 p0080 A79-14794  
Superconductivity for mirror fusion  
22 p0236 A79-20542  
Minimum-average-B wells in linked magnetic mirror  
fields --- for plasma control in fusion reactors  
22 p0252 A79-22237  
Particle orbits in field-reversed mirrors --- for  
plasma confinement in fusion reactor  
22 p0253 A79-22239  
Stabilization of drift loss-cone instability /DCI/  
by addition of cold ions --- in collisional  
hydrogen plasma confinement  
22 p0291 A79-27882  
Evidence for neutral-beam-injected oxygen  
impurities in 2XIB --- mirror confined plasma  
22 p0292 A79-27887  
Radial transport in the ELMO Bumpy Torus in  
collisional regimes  
22 p0312 A79-31184  
MHD gas turbine energy conversion for mirror  
fusion reactors  
22 p0313 A79-31192

## MAGNETIC PROBES

- A scheme for direct conversion of plasma thermal energy into electrical energy 22 p0324 A79-31765
- Overview of the magnetic fusion energy development and technology program [HCP/T3073-01] 21 p0193 N79-11887
- MAGNETIC PROBES**
- Structure of the current shell in a Z pinch 22 p0245 A79-21434

## MAGNETIC SURVEYS

- Magnetotelluric and geoelectric measurements for geothermal exploration in the Phlegraean Fields /preliminary results/ 21 p0075 A79-14732
- Toward assessing the geothermal potential of the Jemez Mountains volcanic complex: A telluric-magnetotelluric survey [LA-7656-MS] 22 p0358 N79-20458
- MAGNETICALLY TRAPPED PARTICLES**
- Characteristics of a predemonstration fusion device 21 p0078 A79-14784
- Asymptotic theory of dissipative trapped electron mode overlapping many rational surfaces --- in toroidal plasmas 22 p0270 A79-24855

## MAGNETOACOUSTIC WAVES

- Magneto-acoustic resonance heating in the ion-cyclotron frequency domain --- of tokamak plasmas 22 p0271 A79-24866
- Dynamic stabilization of toroidal discharges in weak longitudinal magnetic fields 22 p0324 A79-31766

## MAGNETOHYDRODYNAMIC FLOW

- Supersonic flow in an MHD channel with a downwash flow at the inlet 21 p0085 A79-15342
- Effect of force field nonuniformity on flow in an MHD channel 21 p0101 A79-16365
- On the flow of a conducting fluid between parallel disks with a transverse magnetic field. I - A theoretical investigation on a nonequilibrium plasma flow as a compressible inviscid fluid 21 p0156 A79-19445
- Nonstationary two-dimensional magnetohydrodynamic flow in a radial channel 22 p0247 A79-21626
- Optimization of a diagonal MHD channel 22 p0247 A79-21628
- On the diffusive instability of some simple steady magnetohydrodynamic flows 22 p0278 A79-26163
- Two-dimensional MHD channel design --- for energy performance improvement at lower wall temperature 22 p0279 A79-26183
- Velocity, temperature, and electrical conductivity profiles in hydrogen-oxygen MHD duct flows 22 p0279 A79-26184
- Comparison of results of calculation of flow in an MHD generator with experimental data obtained on the U-25 device 22 p0306 A79-30392
- Thermoelectric magnetohydrodynamics 22 p0312 A79-31098

## MAGNETOHYDRODYNAMIC GENERATORS

- Economic optimization of the coal-fired MHD Steam Power Plant 21 p0016 A79-10134
- Reducing combustion air temperature variations in magnetohydrodynamic/steam power plants 21 p0016 A79-10135
- Considerations for MHD power generation development 21 p0016 A79-10136
- A proposed 40 MWe MHD pilot plant 21 p0017 A79-10137
- Thermal modeling of coal-fired MHD plant components 21 p0017 A79-10138
- Controlling NOx from a coal-fired MHD process 21 p0017 A79-10139
- A superconducting dipole magnet system for the MHD facility at Univ. of Tennessee Space Institute 21 p0017 A79-10140
- Progress in the testing of materials and design concepts for directly-fired MHD air heater service 21 p0017 A79-10141
- Design studies and trade-off analyses for a superconducting magnet/MHD power generator system 21 p0017 A79-10142

## SUBJECT INDEX

- The ion fly-wheel effect on the electro-thermal instability in non-equilibrium MHD Hall disc generators 21 p0046 A79-12270
- Magnetohydrodynamic/steam power plant modeling and control 21 p0046 A79-12274
- 'Local' breakdown criterion in highly ionized gas flow 21 p0049 A79-12683
- Stability of combustion in the combustion chamber of an MHD generator 21 p0049 A79-12691
- U-25B MHD unit for carrying out investigations under the conditions of strong electric and magnetic fields 21 p0049 A79-12692
- Channel No. 1 of the MHD generator of a U-25B unit for carrying out investigations in strong electric and magnetic fields 21 p0049 A79-12693
- A collisional plasma rotating between two cylinders 21 p0049 A79-12694
- Combustion of porous particles --- coal for MHD generators 21 p0049 A79-12708
- Attenuating the transverse edge effect in MHD generators 21 p0063 A79-13985
- Coal slag effects in MHD generators 21 p0080 A79-14934
- Corrosion and deposits in MHD generator systems 21 p0081 A79-14935
- Controlled utilization of coal slag in the MHD topping cycle 21 p0081 A79-14936
- The MHD interaction and plasma properties in a shock tube driven disk generator with swirl 21 p0083 A79-15260
- Commercial realization of MHD - A challenge for superconducting magnets 21 p0084 A79-15302
- Cryogenic aspects of the U.S. SCMS superconducting dipole magnet for MHD research 21 p0084 A79-15303
- Fabrication experiences and operating characteristics of the U.S. SCMS superconducting dipole magnet for MHD research 21 p0084 A79-15304
- Design study of superconducting magnets for a combustion magnetohydrodynamic /MHD/ generator 21 p0084 A79-15305
- Design of superconducting magnets for full-scale MHD generators 21 p0084 A79-15306
- Supersonic flow in an MHD channel with a downwash flow at the inlet 21 p0085 A79-15342
- Materials and economics of energy systems 21 p0095 A79-15911
- Effect of force field nonuniformity on flow in an MHD channel 21 p0101 A79-16365
- Open-cycle magnetohydrodynamic electrical power generation --- Book 21 p0104 A79-16478
- The MHD power plant and its environmental aspects - Introduction 21 p0105 A79-16479
- MHD power plant characteristics 21 p0105 A79-16480
- Layout and design characteristics of MHD power stations 21 p0105 A79-16481
- Technical and economic aspects of open-cycle MHD power plants 21 p0105 A79-16482
- Protection of the biosphere --- MHD power stations pollution reduction 21 p0105 A79-16483
- MHD generators --- Faraday, Hall and diagonal generator designs 21 p0105 A79-16484
- Superconducting magnets --- for MHD applications 21 p0105 A79-16485
- Inverter systems --- for MHD power stations 21 p0106 A79-16486

# SUBJECT INDEX

# MAGNETOHYDRODYNAMIC GENERATORS CONTD.

- High-temperature oxidizer preheater --- for fossil fuel MHD energy conversion 21 p0106 A79-16487
- Fuels and combustion --- for open cycle MHD system 21 p0106 A79-16488
- Steam generator and turbomachines --- MHD power plant design and Soviet operational experience 21 p0106 A79-16489
- Ionizing seed --- for open cycle MHD power generation 21 p0106 A79-16490
- Materials --- for high temperature MHD technology 21 p0106 A79-16491
- Plasma diagnostics in an MHD installation 21 p0106 A79-16492
- MHD conversion of solar energy --- space electric power system 21 p0109 A79-16614
- MHD power generation 21 p0146 A79-17638
- Effects of position of output electrodes in entrance region of open-cycle diagonal type MHD generator 21 p0153 A79-18468
- Effect of finite boundary layer on the ionization instability in non-equilibrium MHD generators 21 p0153 A79-18469
- Transport phenomena in MHD generators - Effect of boundary layers 21 p0156 A79-19098
- On the flow of a conducting fluid between parallel disks with a transverse magnetic field. I - A theoretical investigation on a nonequilibrium plasma flow as a compressible inviscid fluid 21 p0156 A79-19445
- National program for the development of commercial MHD [AIAA PAPER 79-0188] 21 p0157 A79-19587
- Slag deposition and its effect on the performance of MHD channels --- in electric generators [AIAA PAPER 79-0189] 21 p0157 A79-19588
- Combustion of pulverized coal in high temperature preheated air [AIAA PAPER 79-0298] 21 p0158 A79-19654
- Slag transport models for radiant heater of an MHD system [ASME PAPER 78-WA/HT-21] 21 p0161 A79-19808
- Experimental measurements and correlations of Nusselt number for MHD high temperature air preheaters [ASME PAPER 78-WA/HT-22] 21 p0161 A79-19809
- Gas stream composition and temperature determination in a coal-fired MHD simulation facility [ASME PAPER 78-WA/HT-23] 21 p0161 A79-19810
- The role of interfacial heat and mechanical energy transfers in a liquid-metal MHD generator [ASME PAPER 78-WA/HT-33] 21 p0161 A79-19814
- Vaporization of drops of a melt of potassium carbonate in a medium of combustion products 21 p0167 A79-20411
- Subsonic flow in the channel of an MHD-generator 21 p0167 A79-20413
- The electric conductivity of a plasma of combustion products of hydrocarbon fuels with alkali impurity 21 p0167 A79-20415
- Mathematical model of interelectrode breakdown in MHD generator 21 p0167 A79-20418
- Effect of the properties of the working body on the selection of the temperature of the surface of the electrodes of the channel of an MHD generator 21 p0167 A79-20419
- Observation of voltage fluctuations in a Superconducting Magnet during MHD power generation 22 p0235 A79-20531
- Design and operating experience of the cryogenic system of the U.S. SCNS as incorporated into the bypass loop of the U-25 MHD generator facility --- Superconducting Magnet System 22 p0235 A79-20532
- A superconducting dipole magnet for the UTSI MHD Facility 22 p0235 A79-20533
- Fabrication and assembly considerations for a base load MHD superconducting magnet system 22 p0235 A79-20534
- Practical aspects of designing and manufacturing MHD superconducting base-load magnets in 1988 time frame 22 p0235 A79-20535
- Experimental studies of a linear MHD generator with fully ionized seed 22 p0238 A79-20796
- Preliminary analysis of advanced ceramic magnetohydrodynamic /MHD/ combustor design concepts 22 p0240 A79-20838
- Investigation of the Hall effect in a discharge with a rotational electric field 22 p0246 A79-21532
- Turbulence of a combustion product plasma in an MHD channel 22 p0246 A79-21538
- Nonstationary two-dimensional magnetohydrodynamic flow in a radial channel 22 p0247 A79-21626
- Accounting for the effect of a yoke in an MHD linear induction machine by stipulating boundary conditions of a new kind 22 p0247 A79-21627
- Optimization of a diagonal MHD channel 22 p0247 A79-21628
- Dynamic characteristics of a free-piston diesel engine combined with a MHD generator 22 p0258 A79-23137
- Construction of a mathematical model for MHD generator electrodes in the arc regime of operation 22 p0258 A79-23138
- Fluids engineering in advanced energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978 22 p0278 A79-26176
- Subsonic diffusers for MHD generators 22 p0279 A79-26185
- On supersonic and subsonic diffusers for magnetohydrodynamic generator applications 22 p0279 A79-26186
- Three-dimensional effects of electrode configuration on diagonal MHD generator performance 22 p0283 A79-26523
- Performance of a closed-cycle MHD generator with molecular impurities 22 p0283 A79-26524
- Calculation and design of liquid-metal MHD induction machines --- Russian book 22 p0286 A79-27302
- Applications of cryogenic technology. Volume 7 - Proceedings of the Conference on Cryogenic Energy Systems, Oak Brook, Ill., May 16-18, 1978 22 p0289 A79-27651
- Open-cycle MHD development --- for power generation 22 p0289 A79-27659
- An overview of liquid metal MHD --- for power generation 22 p0289 A79-27660
- Status of the U.S./U.S.S.R. cooperative program for the development of open-cycle MHD power generators 22 p0290 A79-27661
- Superconducting magnet systems for MHD generator facilities 22 p0290 A79-27662
- Air Force applications of lightweight superconducting machinery --- in airborne power sources 22 p0290 A79-27666
- Operational characteristics of MHD turbine with air-core superconducting rotor 22 p0297 A79-28924
- Optimality criteria in the compensation of the longitudinal boundary effect in induction MHD machines 22 p0298 A79-29277
- Calculation of the external electromagnetic field of closely spaced MHD machines 22 p0298 A79-29285
- Theoretical and computational analysis of MHD machines with two-layer windings and half-filled slots and the inductor edges 22 p0298 A79-29286
- Two asymptotic solutions for analyzing the transverse edge effect in induction MHD machines 22 p0298 A79-29287

- Limit of formation of counterflows in plane linear induction MHD machines 22 p0298 A79-29288
- Equations of a conduction MHD ejector 22 p0298 A79-29289
- Feasibility of MHD-ac induction electric power plant --- using tokamak reactor exhaust plasma 22 p0303 A79-29794
- Control problems of the magnetohydrodynamic electrical power generation in power station cooperating with electrical power system 22 p0303 A79-29798
- Mechanism of erosion of metal electrodes of the channel of a MHD generator [ 22 p0306 A79-30391
- Comparison of results of calculation of flow in an MHD generator with experimental data obtained on the U-25 device 22 p0306 A79-30392
- MHD gas turbine energy conversion for mirror fusion reactors 22 p0313 A79-31192
- Development of the combustion chamber of an experimental MHD generator 22 p0327 A79-32105
- Experimental two-phase liquid-metal magnetohydrodynamic generator program [AD-A059240] 21 p0197 N79-12564
- High energy MHD fuels development program [AD-A060156] 21 p0216 N79-14239
- Magnetohydrodynamic lightweight channel development [AD-A060429] 21 p0230 N79-15414
- MHD generator duct flow with cross stream dependent fluid properties 22 p0336 N79-16668
- Evaluation of the ECAS open cycle MHD power plant design [NASA-TM-79012] 22 p0341 N79-17335
- Experimental investigation on the discharge structure in a noble gas MHD generator [TH-78-E-79] 22 p0350 N79-18758
- Evaluation of the use of oxygen as oxidant in fossil fuel fired open cycle MHD-steam energy conversion processes 22 p0353 N79-19444
- MHD balance of plant technology project [ANL-MHD-78-7] 22 p0361 N79-20500
- Parametric study of the performance of a CDIP 1-B coal-fired MHD generator [ANL-MHD-79-3] 22 p0361 N79-20503
- Development, characterization and evaluation of materials for open cycle MHD [PNL-2004-9] 22 p0361 N79-20504
- Technical support for open-cycle MHD program [ANL-MHD-78-8] 22 p0361 N79-20507
- Critical contributions in MHD power generation [FE-2215-11] 22 p0362 N79-20511
- Axial field limitations in MHD generators [FE-2341-8] 22 p0362 N79-20512
- MHD-ETP program. Volume 1: Executive summary [FE-2613-6-VOL-1] 22 p0362 N79-20515
- MHD-ETP program. Volume 2A, parts 1 and 2: Reference design description [FE-2613-6-VOL-2A] 22 p0363 N79-20516
- MHD power generation: Research, development and engineering [FE-2524-8] 22 p0363 N79-20517
- MHD power generation: Research, development and engineering [FE-3087-2] 22 p0363 N79-20518
- Insulating wall boundary layer in a Faraday MHD generator [FE-23417] 22 p0365 N79-21310
- Development, characterization and evaluation of materials for open cycle MHD [PNL-2004-8] 22 p0369 N79-21557
- Development, testing and evaluation of MHD materials and component designs --- electrode and insulator systems for MHD generators [FE-2248-19] 22 p0369 N79-21558
- Engineering test facility conceptual design, part 1 [FE-2614-2-PT-1] 22 p0369 N79-21560
- Engineering test facility conceptual design, part 2 [FE-2614-2-PT-2] 22 p0369 N79-21561
- MAGNETOHYDRODYNAMIC STABILITY
- The ion fly-wheel effect on the electro-thermal instability in non-equilibrium MHD Hall disc generators 21 p0046 A79-12270
- Review of tokamak theory results 21 p0069 A79-14454
- Progress in tokamak experimental research in the Soviet Union 21 p0069 A79-14455
- The mirror machine program in the USA --- controlled fusion experiments and research facilities 21 p0070 A79-14461
- New results in high-beta stellarator and belt-pinch research 21 p0070 A79-14463
- Present status of two R.F. heating schemes - I.C.R.H. and L.H.R.H. --- Ion Cyclotron Resonant Heating and Lower-Hybrid Resonant Heating of plasma 21 p0071 A79-14467
- Review of experimental results. I, II --- MHD instability effects on tokamak confinement with ohmic heating 21 p0077 A79-14778
- MHD equilibria and stability --- in tokamak devices 21 p0078 A79-14779
- Magnetic divertors --- in large tokamak plasma confinement experiments 21 p0078 A79-14781
- Characteristics of a predemonstration fusion device 21 p0078 A79-14784
- Predemonstration fusion devices - Research and development needs 21 p0078 A79-14785
- Dynamics and feedback control of ISX tokamak 21 p0107 A79-16559
- Effect of finite boundary layer on the ionization instability in non-equilibrium MHD generators 21 p0153 A79-18469
- Effect of the magnetic configuration of the poloidal diverter on the plasma in the T-12 finger-ring tokamak 22 p0244 A79-21429
- Space-dependent thermal stability of reacting tokamak plasmas 22 p0253 A79-22242
- Local theory of finite-beta, collisional drift modes --- plasma stability analysis 22 p0253 A79-22244
- Non-linear numerical algorithms for studying tearing modes --- in tokamaks 22 p0257 A79-22981
- MHD instabilities 22 p0259 A79-23599
- Stability criteria for current-driven drift wave eigenmodes --- in tokamaks 22 p0269 A79-24813
- Parametric decay of lower hybrid waves in a plasma - Effect of ion nonlinearity --- in tokamaks 22 p0269 A79-24814
- Microstability of a focused ion beam propagating through a z-pinch plasma 22 p0270 A79-24817
- Electrons of high perpendicular energy in the low-density regime of tokamaks 22 p0270 A79-24852
- Asymptotic theory of dissipative trapped electron mode overlapping many rational surfaces --- in toroidal plasmas 22 p0270 A79-24855
- Theory of anomalous transport due to electrostatic fluctuations --- low frequency plasma instabilities of drift wave type 22 p0270 A79-24858
- Quasi-linear theory of heat flow and diffusion in a tokamak 22 p0270 A79-24859
- Integral invariants and quasi-MHD nonlinear dissipation --- in magnetized toroidal plasmas 22 p0270 A79-24862
- MHD stability for a spherator with a purely poloidal magnetic field 22 p0271 A79-24863
- On the diffusive instability of some simple steady magnetohydrodynamic flows 22 p0278 A79-26163
- Macroscopic stability and beta limit in the ELMO Bumpy Torus 22 p0291 A79-27876
- The effect of limiters and current profile on elliptic free-boundary MHD equilibria 22 p0291 A79-27881



# SUBJECT INDEX

# HARRET RESEARCH

- Stabilization of drift loss-cone instability /DCI/  
by addition of cold ions --- in collisional  
hydrogen plasma confinement 22 p0291 A79-27882
- Theory of dissipative drift instabilities in  
sheared magnetic fields --- in confined toroidal  
plasmas 22 p0292 A79-27884
- Theory of the striated corona in a theta pinch 22 p0295 A79-28315
- MHD stability of Spheronak 22 p0313 A79-31189
- Relaxation of a fast ion beam in a tokamak plasma 22 p0324 A79-31760
- Experiments on controlling the plasma density in  
the TO-1 tokamak 22 p0324 A79-31762
- A scheme for direct conversion of plasma thermal  
energy into electrical energy 22 p0324 A79-31765
- Dynamic stabilization of toroidal discharges in  
weak longitudinal magnetic fields 22 p0324 A79-31766
- The formulation of the wall stabilization problem  
of an axisymmetrical toroidal sharp-boundary  
plasma with a horizontally elongated noncircular  
cross section 22 p0327 A79-32103
- MAGNETOHYDRODYNAMICS**  
Experimental two-phase liquid-metal  
magnetohydrodynamic generator program  
[AD-A059240] 21 p0197 N79-12564
- High pressure MHD coal combustors investigation  
[PB-2706-08] 22 p0362 N79-20510
- MAGNETOSPHERE**  
Changes in the terrestrial  
atmosphere-ionosphere-magnetosphere system due  
to ion propulsion for solar power satellite  
placement [NASA-TM-79719] 22 p0345 N79-17897
- MAINTENANCE**  
The impact of servicing requirements on tokamak  
fusion reactor design 21 p0079 A79-14793
- Is there repair after failure --- reliability of  
repairable vs. nonrepairable engines 21 p0086 A79-15378
- Gas turbine operating and maintenance experience  
in Saudi Arabia 22 p0298 A79-28989
- MAN ENVIRONMENT INTERACTIONS**  
Energy/environment technology areas to be developed  
21 p0097 A79-16077
- MANAGEMENT INFORMATION SYSTEMS**  
Federal Energy Data System (FEDS) technical  
documentation [PB-281815/1] 21 p0189 N79-11542
- Geothermal emissions data base: Cerro Prieto  
geothermal field [UCID-4033] 21 p0204 N79-13480
- Development of an Air Force facilities energy  
information system [AD-A059309] 21 p0223 N79-14918
- MANAGEMENT METHODS**  
Strategies for applied research management  
[PB-284741/6] 21 p0214 N79-13913
- Thermal power systems small power systems  
applications project. Decision analysis for  
evaluating and ranking small solar thermal power  
system technologies. Volume 1: A brief  
introduction to multiattribute decision analysis  
--- explanation of multiattribute decision  
analysis methods used in evaluating alternatives  
for small powered systems [NASA-CR-158425] 22 p0368 N79-21548
- Conservation where it counts: Energy management  
systems [PB-289837/7] 22 p0372 N79-21628
- MANAGEMENT PLANNING**  
Development of industrial owned, small-  
hydroelectric facilities 21 p0073 A79-14699
- A planning and information system for strategic  
energy policy assessment --- Book 22 p0259 A79-23600
- Environmental development Plan (EDP). Oil supply,  
FY 1977 [DOE/EDP-0024] 21 p0175 N79-10545
- Solid waste and biomass. Their potential as  
energy sources in Illinois, 1977 [PB-281649/4] 21 p0177 N79-10562
- US Navy energy plan and program, 1978  
[AD-A058054] 21 p0197 N79-12560
- Army energy plan [AD-A057987] 21 p0197 N79-12562
- Solar Heating And Cooling Of Buildings (SHACOB)  
commercialization report. Part A: Options and  
strategies. Volume 1: Executive summary  
[HCP/H70065-01/1] 21 p0207 N79-13512
- Assessment of economic factors affecting the  
satellite power system. Volume 1: System cost  
factors [NASA-CR-161185] 22 p0368 N79-21551
- MANAGEMENT SYSTEMS**  
Army facility energy conservation 21 p0028 A79-10233
- MANNED SPACE FLIGHT**  
Overview of future programs - USA --- manned  
orbital space missions 21 p0116 A79-17275
- FY 1978 scientific and technical reports,  
articles, papers, and presentations ---  
bibliography [NASA-TM-78203] 21 p0214 N79-13915
- MANNED SPACECRAFT**  
Manned remote work station development article  
[NASA-CR-151871] 22 p0330 N79-16057
- MANUALS**  
Standards of Practice Manual for the solvent  
refined coal liquefaction process  
[PB-283028/9] 21 p0178 N79-10595
- MANUFACTURING**  
Manufacture of curved glass mirrors for linear  
concentrators 21 p0136 A79-17459
- Silicon sheet growth development for the large  
area sheet task of the low cost solar array  
project. Heat exchanger method - ingot casting  
fixed abrasive method - multi-wire slicing  
[NASA-CR-158038] 21 p0219 N79-14540
- Pilot line report: Development of a high  
efficiency thin silicon solar cell  
[NASA-CR-158028] 21 p0219 N79-14548
- Evaluation of the technical feasibility and  
effective cost of various wafer thicknesses for  
the manufacture of solar cells [NASA-CR-158095] 22 p0334 N79-16368
- MARINE BIOLOGY**  
Marine biological effects of OCS petroleum  
development [PB-288935/0] 22 p0344 N79-17374
- MARINE CHEMISTRY**  
Organic geochemical studies on kerogen precursors  
in recently deposited algal mats and oozes  
21 p0031 A79-10419
- MARINE ENVIRONMENTS**  
Prefabricated caissons for tidal power development  
21 p0152 A79-18113
- Determining the reliability of radioisotope  
thermoelectric generators /RTGs/ designed for  
terrestrial and undersea applications 22 p0261 A79-23622
- Oceans '78: The ocean challenge; Proceedings of  
the Fourth Annual Combined Conference,  
Washington, D.C., September 6-8, 1978  
22 p0287 A79-27376
- Environmental considerations for siting an ocean  
thermal conversion early ocean testing platform  
at four proposed areas 22 p0287 A79-27377
- Oil pollution reports, volume 5, number 2 ---  
bibliographies [PB-287071/5] 22 p0336 N79-16437
- MARINE PROPULSION**  
Sail power for the world's cargo ships  
22 p0305 A79-30374
- Proceedings of symposium on water-in-fuel  
emulsions in combustion --- marine diesels,  
boilers, and gas turbine engines  
[AD-A061503] 22 p0338 N79-17019
- MARINE TECHNOLOGY**  
Principles of design and construction for marine  
structures for wave/tidal/ocean thermal energy  
21 p0152 A79-18114
- HARRET RESEARCH**  
An overview of solar markets 21 p0092 A79-15884

# MARKETING

# SUBJECT INDEX

Factors influencing solar energy commercialization 21 p0093 A79-15897

Market penetration for OTEC 21 p0094 A79-15903

An economist looks at solar energy - The government's role 21 p0099 A79-16132

Factors affecting market initiation of solar total energy 21 p0112 A79-16732

Macro-energy model - Impact of public policy on technological development 21 p0113 A79-16741

Use of solar energy for industrial process heat 21 p0143 A79-17524

Accelerating the commercialization on new technologies --- free market operation of federal alternate energy sources programs [ASME PAPER 78-WA/TS-4] 21 p0164 A79-19849

Gasification of coal with high-temperature reactor heat - Investigations concerning the market and the economics 22 p0264 A79-23828

Solar Heating And Cooling Of Buildings (SHACOB) commercialization report. Part B: Analysis of market development, volume 2 [HCP/M70066-01/2] 21 p0207 N79-13513

Heat pump technology: A survey of technical developments, market prospects and research needs [HCP/M2121-01] 21 p0210 N79-13540

Lead-acid battery: An evaluation of commercialization strategies [MTR-7593] 21 p0220 N79-14565

Engine requirements for future general aviation aircraft 22 p0329 N79-15968

Market definition studies for photovoltaic highway applications [NASA-CR-159477] 22 p0354 N79-19451

Methodology for modeling geothermal district heating for residential markets [BNL-50905] 22 p0361 N79-20502

**MARKETING**

Coal preparation design for export markets, with particular reference to South African and Canadian coals 22 p0340 N79-17318

Influence of marketing requirements on definition of coal resources 22 p0340 N79-17319

**MARKOV CHAINS**

A Markov model of solar energy systems 21 p0138 A79-17476

A Markov model of solar energy space and hot water heating systems 22 p0295 A79-28353

**MARKOV PROCESSES**

Storage tank efficiency as simulated in a Markovian model of meteorology 22 p0254 A79-22272

**MARS SURFACE**

Feasibility of rocket propellant production on Mars 21 p0047 A79-12324

**MARYLAND**

The energy dilemma: A challenge for Maryland. Proceedings Maryland General Assembly/AISLE Conference [PB-284703/6] 21 p0199 N79-12579

**MASS RATIOS**

Parametric study of two planar high power flexible solar array concepts [NASA-CR-157841] 21 p0205 N79-13501

**MASS TRANSFER**

Rate of desorption in a solar regenerator 21 p0055 A79-13611

Mass transfer in a current source during circulation of the mixture driven by gaseous reaction products --- in fuel cell 21 p0164 A79-19851

Experimental study of the characteristics of heat and mass transfer in a two-component low-temperature heat pipe 22 p0246 A79-21585

**MATERIAL ABSORPTION**

Wilson parameters for the system H<sub>2</sub>, N<sub>2</sub>, CO, CO<sub>2</sub>, CH<sub>4</sub>, H<sub>2</sub>S, CH<sub>3</sub>OH, and H<sub>2</sub>O --- for cold methanol absorption in coal gasification 22 p0282 A79-26462

**MATERIAL BALANCE**

Weak points of our prediction models for raw materials strategy --- waste materials and scrap recycling 22 p0265 A79-24040

**MATERIALS**

Materials for fuel cells [PB-285360/4] 21 p0212 N79-13553

**MATERIALS HANDLING**

Measured air flow rates through microorifices and flow prediction capability [PB-286868/5] 21 p0217 N79-14344

**MATERIALS RECOVERY**

New processes for the recovery of resource materials from coal combustion wastes 21 p0007 A79-10065

Evaluation of the Ames, Iowa refuse derived fuel recovery system 21 p0064 A79-14115

Energy from urban waste 21 p0096 A79-15917

Toward a materials-conservation ethic 21 p0167 A79-20438

Weak points of our prediction models for raw materials strategy --- waste materials and scrap recycling 22 p0265 A79-24040

Development of specifications for recycled products 22 p0295 A79-28182

Modern technology for recovering energy and materials from urban wastes - Its applicability in developing countries 22 p0295 A79-28183

Utilisation of solid waste 22 p0304 A79-30204

A methodology for evaluating the potential materials and energy recovery from municipal solid waste 21 p0215 N79-13935

Bureau of Mines research 1977. A summary of significant results in mining, metallurgy, and mineral economics [PB-284743/2] 21 p0217 N79-14521

Trace element characterization and removal/recovery from coal and coal wastes [LA-7048-PB] 21 p0222 N79-14602

**MATERIALS TESTS**

Progress in the testing of materials and design concepts for directly-fired MHD air heater service 21 p0017 A79-10141

Evaluation program for new industrial gas turbine materials [ASME PAPER 78-GT-145] 21 p0031 A79-10269

Designing and testing Si3N4 turbine components at Mercedes-Benz 21 p0050 A79-12830

Evaluated physical properties data for materials used in energy storage systems [UCRL-81159] 21 p0189 N79-11536

**MATHEMATICAL MODELS**

Preliminary controller evaluation for the MERC/CTIU using a mathematical process model --- of Component Test and Integration Unit in fluidized bed combustion 21 p0008 A79-10073

Transient energy removal in cylindrical parabolic collector systems 21 p0020 A79-10168

Analysis of electrolyte shunt currents in fuel cell powerplants 21 p0039 A79-11816

A numerical solar radiation model based on standard meteorological observations --- for energy system application 21 p0041 A79-11871

Predicting the performance of passive solar-heated buildings 21 p0063 A79-13899

A probabilistic model of insolation for the Mojave desert-area 21 p0076 A79-14766

Modelling energy storage systems for electric utility applications Preliminary considerations 21 p0081 A79-14960

Control of wind turbine generators connected to power systems 21 p0086 A79-15574

## SUBJECT INDEX

## MECHANICAL DRIVES

- Temperature dependent parameter analysis of thermoelectric devices 21 p0113 A79-16740
- Macro-energy model - Impact of public policy on technological development 21 p0113 A79-16741
- Determining the terrestrial, incident solar flux on an arbitrarily oriented surface using available solar/weather data 21 p0119 A79-17310
- Underground aquifer storage of hot water from solar energy collectors 21 p0120 A79-17317
- A parametric investigation on flat-plate solar collectors 21 p0128 A79-17391
- The analysis by stochastic modelling of solar systems for space and water heating 21 p0137 A79-17466
- Stochastic simulation experiments on solar air conditioning systems 21 p0138 A79-17474
- A Markov model of solar energy systems 21 p0138 A79-17476
- Modeling energy and power requirements of electric vehicles 21 p0153 A79-18465
- The advanced thermionic converter with microwave power as an auxiliary ionization source 21 p0153 A79-18470
- Energy related mathematical models - Annotated bibliography 21 p0154 A79-18472
- Fundamentals of mathematical modeling of solar-radiation regime energy structure 21 p0166 A79-20352
- Mathematical model of interelectrode breakdown in MHD generator 21 p0167 A79-20418
- Space-dependent thermal stability of reacting tokamak plasmas 22 p0253 A79-22242
- Prediction of the behavior of a solar storage system by means of recurrent stochastic models --- of insolation 22 p0258 A79-23295
- Modeling and simulation. Volume 9 - Proceedings of the Ninth Annual Pittsburgh Conference, University of Pittsburgh, Pittsburgh, Pa., April 27, 28, 1978. Part 1 - Energy and power system modeling - Ecological and biomedical modeling. Part 2 - Socioeconomic modeling. Part 3 - Control and identification. Part 4 Methodology and applications 22 p0263 A79-23776
- A fundamental model for the evolution of a two-phase geothermal reservoir with application to environmental impact analysis 22 p0263 A79-23777
- A liquid solar energy storage tank model. I - Formulation of a mathematical model 22 p0267 A79-24314
- The interaction of the wind field with a horizontal axis wind turbine 22 p0278 A79-26177
- A two dimensional vortex sheet model of a Savonius Rotor 22 p0278 A79-26178
- Modeling two-phase flow in a swirl combustor 22 p0280 A79-26189
- Modeling the champagne effect in compressed air energy storage 22 p0280 A79-26190
- Direct solar transmittance for a clear sky --- for insolation of solar conversion systems 22 p0296 A79-28361
- Study of integrated gasification combined cycle plant interaction and control [ASME PAPER 79-GT-60] 22 p0306 A79-30530
- Fiat Research Center hybrid vehicle prototype [SAE PAPER 790014] 22 p0313 A79-31351
- Mathematical modelling of passive solar systems 22 p0321 A79-31441
- Measured and modeled passive performance in Montana --- for solar heating and thermal storage 22 p0322 A79-31445
- A numerical model investigation of tidal phenomena in the Bay of Fundy and Gulf of Maine 22 p0323 A79-31554
- Kinetic modeling of pyrolysis and hydrogasification of carbonaceous materials --- converting wood waste char to clean fuels 21 p0179 A79-11150
- Computer modeling of automotive engine combustion [UCRL-80451] 21 p0181 A79-11412
- Battery Energy Storage Test (BEST) Facility. Phenomenological cell modeling: A tool for planning and analyzing battery testing at the BEST facility [COO-2857-1] 21 p0184 A79-11490
- Solar Heating And Cooling Of Buildings (SHACOB) commercialization report. Part A: Options and strategies. Volume 1: Executive summary [HCP/M70065-01/1] 21 p0207 A79-13512
- Solar Heating And Cooling Of Buildings (SHACOB) commercialization report. Part B: Analysis of market development, volume 2 [HCP/M70066-01/2] 21 p0207 A79-13513
- Development of a model and computer code to describe solar grade silicon production processes --- phase changes in chemical reactors [NASA-CR-158037] 21 p0219 A79-14555
- Parameter estimation and validation of a solar assisted heat pump model 22 p0332 A79-16349
- Water/energy management and evaluation model for Pennsylvania [PB-287577/1] 22 p0343 A79-17353
- Electrolysis of zinc. Statistical model of the process parameters for an industrial cell [BLL-RTS-11317] 22 p0345 A79-17984
- Two-dimensional analysis of vertical axis windmills 22 p0353 A79-19446
- Analytical modelling of oil recovery by steam injection 22 p0358 A79-20434
- Simulation of fluidized bed coal combustors [NASA-CR-159529] 22 p0359 A79-20487
- Methodology for modeling geothermal district heating for residential markets [BNL-50905] 22 p0361 A79-20502
- Insulating wall boundary layer in a Faraday MHD generator [FE-23417] 22 p0365 A79-21310
- MEASURING INSTRUMENTS
- Instrumentation development for in situ coal gasification 21 p0006 A79-10053
- Technique and instrumentation for measuring the performance of integrated solar heating/cooling systems 21 p0087 A79-15830
- Sensor selection and placement in the National Solar Data Program 21 p0089 A79-15844
- Plasma diagnostics in an MHD installation 21 p0106 A79-16492
- International Instrumentation Symposium, 24th, Albuquerque, N. Mex., May 1-5, 1978, Proceedings. Parts 1 & 2 21 p0144 A79-17576
- Sensitivity of slope measurements on parabolic solar mirrors to positioning and alignment of the laser scanner [SAND-78-0700] 21 p0185 A79-11496
- Borehole geological assessment [NASA-CASE-WFO-14231-1] 22 p0356 A79-19521
- MECHANICAL DRIVES
- Mechanical efficiency of the Stirling cycle machine with rhombic drive 21 p0025 A79-10208
- Torque ripple in a vertical axis wind turbine 21 p0029 A79-10239
- A small horizontal axis wind turbine feeding power into the utility grid 21 p0074 A79-14703
- The Power Wheel - Elimination of energy-consuming drive components 21 p0112 A79-16734
- Flywheel energy accumulators for road vehicles 22 p0241 A79-20845
- Production of mechanical energy by thermodynamic conversion of solar energy 22 p0310 A79-30999

- Performance characteristics of automotive engines in the United States. First Series: Report No. 14 1975 Mazda Rotary 79 CID (1.1 Liters), 4V --- fuel consumption and emissions [PB-286074/0] 21 p0226 N79-15304
- The rotary combustion engine: A candidate for general aviation --- conferences [NASA-CP-2067] 22 p0329 N79-15961
- Development status of rotary engine at Toyo Kogyo --- for general aviation aircraft 22 p0329 N79-15964
- Update of development on the new Audi NSU rotary engine generation --- for application to aircraft engines 22 p0329 N79-15965
- Review of the Rhein-Flugzeugbau Wankel powered aircraft program --- ducted fan engines 22 p0329 N79-15966
- Rotary engine developments at Curtiss-Wright over the past 20 years and review of general aviation engine potential --- with direct chamber injection 22 p0329 N79-15967
- Engine requirements for future general aviation aircraft 22 p0329 N79-15968
- Power train analysis for the DOE/NASA 100-kW wind turbine generator [NASA-TN-78997] 22 p0333 N79-16355
- Characterization study of an electric motor-transmission system for electric vehicles [HCP/M2835-01] 22 p0351 N79-18817
- MECHANICAL ENGINEERING**
- The Otto-engine-equivalent vehicle concept [NASA-CR-157840] 21 p0203 N79-13370
- Engineering handbook on the atmospheric environmental guidelines for use in wind turbine generator development [NASA-TP-1359] 21 p0223 N79-14679
- MECHANICAL PROPERTIES**
- An operating 200 kW horizontal axis wind turbine 22 p0240 A79-20829
- Comparative properties of fiber composites for energy-storage flywheels part A. Evaluation of fibers for flywheel rotors --- Kevlar/epoxy and glass/epoxy composites [UCRL-80116-PT-A] 21 p0215 N79-14165
- MECHANIZATION**
- Study of flywheel energy storage. Volume 3: System mechanization [PB-282654/3] 21 p0177 N79-10557
- MEDICAL ELECTRONICS**
- Modeling and simulation. Volume 9 - Proceedings of the Ninth Annual Pittsburgh Conference, University of Pittsburgh, Pittsburgh, Pa., April 27, 28, 1978. Part 1 - Energy and power system modeling - Ecological and biomedical modeling. Part 2 - Socioeconomic modeling. Part 3 - Control and identification. Part 4 Methodology and applications 22 p0263 A79-23776
- MELTING**
- Study of the dynamics of the materials melting process for a solar furnace 21 p0167 A79-20359
- MEMBRANES**
- Dual membrane hollow fiber fuel cell and method of operating same [NASA-CASE-NPO-13732-1] 21 p0172 N79-10513
- MERCURY (METAL)**
- Mercury in some New Zealand geothermal discharges 22 p0257 A79-22925
- Antimony, arsenic, and mercury in the combustible fraction of municipal solid waste [PB-285196/2] 21 p0213 N79-13590
- An assessment of mercury emissions from fossil fueled power plants [PB-285227/5] 21 p0213 N79-13592
- MESOMETEOROLOGY**
- Wind characteristics program element [PNL-2545] 22 p0356 N79-19568
- METAL AIR BATTERIES**
- Mechanically rechargeable, metal-air batteries for automotive propulsion 21 p0011 A79-10093
- Iron-air batteries for electric vehicles 21 p0011 A79-10094
- Mechanically rechargeable, metal-air batteries for automotive propulsion [UCRL-81178] 21 p0189 N79-11538
- METAL COATINGS**
- On the mechanism of the electrocatalytic oxygen reduction with particular regard to metal chelates --- in fuel cell electrodes 21 p0038 A79-11808
- Selective solar absorbers --- coatings for solar collector applications 21 p0057 A79-13646
- Selective coatings for aluminum and steel solar absorbers 21 p0058 A79-13647
- Solaronyx - Selective coating for solar energy absorbers 21 p0058 A79-13648
- Selective coatings for solar energy conversion 21 p0126 A79-17376
- New processes for black coatings useful in harnessing solar energy. I - A room temperature black chromium plating bath 21 p0127 A79-17379
- Casing materials for sodium/sulfur cells 22 p0245 A79-21481
- Selective absorption of solar energy in ultrafine metal particles - Model calculations 22 p0273 A79-25746
- Optimization studies on black chrome electroplating variables for solar selective surfaces 22 p0317 A79-31407
- Metallurgical coatings 1978; Proceedings of the Fifth International Conference, San Francisco, Calif., April 3-7, 1978. Volumes 1 & 2 22 p0327 A79-31951
- Electromagnetic radiation energy arrangement --- coatings for solar energy absorption and infrared reflection [NASA-CASE-WOO-00428-1] 22 p0352 N79-19186
- METAL COMPOUNDS**
- Electrochemistry of lithium/metal sulfide and calcium/metal sulfide cells using molten salt electrolytes 21 p0040 A79-11832
- High energy metal hydride fuel cell power source [AD-A056491] 21 p0184 N79-11485
- METAL FIBERS**
- Development of cryogenic targets for laser fusion 21 p0085 A79-15333
- METAL FILMS**
- The dependence of optical properties on the structural composition of solar absorbers - Gold black 22 p0242 A79-21162
- Gold, silver, chromium, and copper cermet selective surfaces for evacuated solar collectors 22 p0256 A79-22855
- Microstructure dependence of the optical properties of solar-absorbing black chrome 22 p0256 A79-22858
- Study of the spectral characteristics of metallized polymer films for production of solar concentrators 22 p0297 A79-28672
- Selective-black absorbers using sputtered cermet films 22 p0327 A79-31969
- METAL FOILS**
- Melting multifoil insulation for KIPS emergency cooling --- Kilowatt Isotope Power System 21 p0023 A79-10191
- Field performance of certain selective and neutral surfaces in solar collectors 21 p0131 A79-17417
- METAL HALIDES**
- Coal gasification studies. II - Reduction in the presence of I2 with H2, and H2O/+ metal, at pressures up to 3500 p.s.i. and temperatures of 600 C in all quartz reactors 22 p0283 A79-26468
- Coal gasification studies. III - Reduction in the presence of some metal iodides and iron halides 22 p0299 A79-29314
- METAL HYDRIDES**
- Model predictions for the stability of ternary metallic hydrides 21 p0038 A79-11802
- Absorption of hydrogen by the intermetallics NdNi5 and LaNi4Cu and a correlation of cell volumes and desorption pressures 21 p0038 A79-11804

# SUBJECT INDEX

# METAL-GAS SYSTEMS

New alloy systems for hydrogen storage 21 p0038 A79-11806

Metal hydride solar heat pump and power system  
/HYCSOS/  
[AIAA PAPER 78-1762] 21 p0061 A79-13863

Hydrides for energy storage; Proceedings of the  
International Symposium, Geilo, Norway, August  
14-19, 1977 22 p0247 A79-21676

Structure and bonding in metal hydrides 22 p0247 A79-21679

Thermodynamics of metal, alloy and  
intermetallic/hydrogen systems 22 p0248 A79-21680

Structural studies of hydrides by neutron  
diffraction 22 p0248 A79-21681

Localization and diffusion of hydrogen in  
lanthanum-nickel compounds 22 p0248 A79-21682

Nuclear magnetic resonance studies of metal hydrides 22 p0248 A79-21683

NMR studies of hydrogen relaxation and diffusion  
in  $TiFeH_{x/2}$  and  $TiFe_{1-y}Mn_{y/2}H_{x/2}$  22 p0248 A79-21684

Electronic structure and physical properties of  
Ti-H and Zr-H using NMR 22 p0248 A79-21685

Electronic states of concentrated Pd-H alloys from  
de Haas-van Alphen measurements 22 p0248 A79-21686

The storage and release of hydrogen from magnesium  
alloy hydrides for vehicular applications 22 p0249 A79-21688

Calculated heats of formation of metal and metal  
alloy hydrides 22 p0249 A79-21690

Acoustic emissions during hydride formation 22 p0249 A79-21691

Magnetic and electrical properties of rare earth  
and rare earth intermetallic hydrides 22 p0249 A79-21692

Hydrogen absorption in rare earth intermetallic  
compounds 22 p0249 A79-21693

Some applications of LaNi5-type hydrides --- using  
reversible reaction with hydrogen working fluid  
for heat storage 22 p0249 A79-21694

Metal hydride electrodes for electrochemical  
energy storage 22 p0249 A79-21695

Hydrides of rare earth-nickel compounds -  
Structure and formation enthalpies 22 p0250 A79-21697

The plateau pressure of RE Ni5 and RE Co5 hydrides  
--- in hydride formation 22 p0250 A79-21698

Synthesis and properties of useful metal hydrides  
- A review of recent work at Brookhaven National  
Laboratory 22 p0250 A79-21699

The use of FeTi-hydride for production and storage  
of ultrapure hydrogen 22 p0250 A79-21700

Hydride formation of C14-type Ti alloy 22 p0250 A79-21701

Hydrogen sorption properties in binary and  
pseudobinary intermetallic compounds 22 p0250 A79-21702

The metallurgy and production of rechargeable  
hydrides --- for hydrogen storage 22 p0250 A79-21703

A new rationale for the hysteresis effects  
observed in metal-hydrogen systems 22 p0250 A79-21704

Heat transfer characteristics of porous metallic  
matrix metal-hydrides 22 p0251 A79-21706

The effect of induced disorder on the  
hydrogenation behaviour of the phase ZrCo 22 p0251 A79-21707

Electrochemical utilization of metal hydrides 22 p0251 A79-21709

Hydrogen electrochemical storage by substituted  
LaNi5 compounds 22 p0251 A79-21711

Applications of metal hydrides --- emphasizing use  
as energy storage media 22 p0251 A79-21715

The hydrogen/hydride energy concept 22 p0252 A79-21717

The iron-titanium - hydrogen system: A  
transmission electron microscope /TEM/ study 22 p0285 A79-26947

**METAL MATRIX COMPOSITES**  
Heat pulses required to quench a potted  
superconducting magnet 22 p0236 A79-20538

**METAL OXIDE SEMICONDUCTORS**  
Optimum antireflection coating for  
Antireflection-coated Metal-Oxide-Semiconductor  
/AMOS/ solar cells 21 p0042 A79-11955

On the role of interface states in MOS solar cells 21 p0122 A79-17337

On the role of interface states in MOS solar cells 21 p0156 A79-19092

**METAL OXIDES**  
Growth of refractory oxide layers by  
electrochemical/vapor deposition /EVD/ at  
elevated temperatures --- for fuel cells 21 p0039 A79-11812

**METAL PARTICLES**  
Selective absorption of solar energy by ultrafine  
metal particles 21 p0127 A79-17382

Selective absorption of solar energy in ultrafine  
metal particles - Model calculations 22 p0273 A79-25746

**METAL PLATES**  
A study for optimum use of metallic plates for  
thermal storage in solar processes 21 p0122 A79-17331

A wave power machine using free floating vertical  
plates 21 p0151 A79-18104

**METAL POWDER**  
Heat transfer characteristics of porous metallic  
matrix metal-hydrides 22 p0251 A79-21706

**METAL SHEETS**  
Optimum collection geometries for copper tube -  
copper sheet flat plate collectors 21 p0127 A79-17387

**METAL SURFACES**  
High reliability contacts for miniature  
thermoelectric converters 21 p0027 A79-10228

Chloride corrosion and its inhibition in refuse  
firing 21 p0080 A79-14930

Investigation of the corrosion performance of  
boiler, air heater, and gas turbine alloys in  
fluidized combustion systems 21 p0080 A79-14931

Corrosion of superalloys, inconels, and stainless  
steels by the products from fluidized-bed coal  
combustion 21 p0080 A79-14932

Status report on selective surfaces --- solar  
collector absorbers 21 p0126 A79-17374

Investigation and perspectives on iron oxide, zinc  
conversion coating, zinc oxide, cobalt oxide and  
tungsten oxide as spectral selective solar  
absorber surfaces 21 p0126 A79-17375

The structure and properties of Cu based selective  
surfaces formed on an Al-Cu alloy by chemical  
brightening and etching treatments --- for flat  
plate solar collectors 21 p0127 A79-17384

Mechanism of erosion of metal electrodes of the  
channel of a MHD generator 22 p0306 A79-30391

**METAL VAPORS**  
Absorption of solar radiation by alkali vapors ---  
for efficient high temperature energy converters 21 p0108 A79-16612

**METAL-GAS SYSTEMS**  
Hydrogen storage by LaNi5 - Fundamentals and  
applications 21 p0038 A79-11803

## METALLIZING

## SUBJECT INDEX

- Thermodynamics of pressure plateaus in metal-hydrogen systems 22 p0238 A79-20772
- Hydrogen storage electrode systems 22 p0251 A79-21710
- Applications of metal hydrides --- emphasizing use as energy storage media 22 p0251 A79-21715
- The iron-titanium - hydrogen system: A transmission electron microscope /TEM/ study 22 p0285 A79-26947
- METALLIZING**
- Development of economical improved thick film solar cell contact [NASA-CR-158358] 22 p0359 A79-20486
- METALLOGRAPHY**
- The metallurgy and production of rechargeable hydrides --- for hydrogen storage 22 p0250 A79-21703
- METALLURGY**
- Metallurgical coatings 1978; Proceedings of the Fifth International Conference, San Francisco, Calif., April 3-7, 1978. Volumes 1 & 2 22 p0327 A79-31951
- Bureau of Mines research 1977. A summary of significant results in mining, metallurgy, and mineral economics [PB-284743/2] 21 p0217 A79-14521
- METALS**
- Solar cells having integral collector grids [NASA-CASE-LEW-12819-1] 21 p0182 A79-11467
- Energy use patterns for metal recycling [PB-284855/4] 21 p0201 A79-13152
- Demetallization catalyst tests on heavy residual oils [PB-285937/9] 21 p0232 A79-15864
- METEOROLOGICAL CHARTS**
- Effects of weather and pollution on incident solar energy - Basic measurements leading to computer models 21 p0065 A79-14117
- Solar radiation charts --- monthly average insolation 22 p0263 A79-23763
- On the use of synoptic weather map typing to define solar radiation regimes 22 p0272 A79-25392
- METEOROLOGICAL PARAMETERS**
- A numerical solar radiation model based on standard meteorological observations --- for energy system application 21 p0041 A79-11871
- Power extracted from the wind 21 p0058 A79-13650
- Total solar radiation in Mexico using sunshine hours and meteorological data 21 p0150 A79-18026
- Stochastic predictions of solar cooling system performance [ASME PAPER 78-WA/SOL-16] 21 p0164 A79-19848
- Storage tank efficiency as simulated in a Markovian model of meteorology 22 p0254 A79-22272
- The role of applied meteorology in the Canadian energy programme 22 p0317 A79-31414
- METEOROLOGICAL SATELLITES**
- Use of satellites in solar applications --- for insolation mapping and space power stations 21 p0104 A79-16468
- Synchronous meteorological and geostationary operational environmental satellites battery and power system design 22 p0370 A79-21571
- METHANE**
- Aspects of pulsating combustion --- gaseous methane burning system 21 p0008 A79-10072
- Feasibility of rocket propellant production on Mars 21 p0047 A79-12324
- Rare earth and actinide intermetallics as hydrogenation catalysts 22 p0251 A79-21713
- Methane generation from human, animal, and agricultural wastes [PB-276469/4] 21 p0171 A79-10240
- Comparative automotive engine operation when fueled with ethanol and methanol [HCP/W1737-01] 21 p0201 A79-13189
- Methane production from carbon oxides over borohydride-reduced transition metals [PB-286385/0] 21 p0226 A79-15177
- Methane utilization from coalbeds for power generation [TID-28408] 22 p0352 A79-19171
- Synthetic fuels: Methane. Citations from the Engineering Index data base [NTIS/PS-79/0030/1] 22 p0365 A79-21223
- METHODOLOGY**
- A methodology for evaluating the potential materials and energy recovery from municipal solid waste 21 p0215 A79-13935
- Methodology for modeling geothermal district heating for residential markets [BNL-50905] 22 p0361 A79-20502
- METHYL ALCOHOLS**
- Novel technology for conversion of methanol and synthesis gas to hydrocarbons 21 p0007 A79-10064
- Development of a 1 kW fuel cell aggregate with acid electrolyte 21 p0148 A79-17994
- Wilson parameters for the system H<sub>2</sub>, N<sub>2</sub>, CO, CO<sub>2</sub>, CH<sub>4</sub>, H<sub>2</sub>S, CH<sub>3</sub>OH, and H<sub>2</sub>O --- for cold methanol absorption in coal gasification 22 p0282 A79-26462
- On future carburants. II --- alternative fuels from alcohols and hydrogen 22 p0296 A79-28439
- Methanol from wood waste: A technical and economic study [FPL-12] 21 p0194 A79-12239
- MEXICO**
- Total solar radiation in Mexico using sunshine hours and meteorological data 21 p0150 A79-18026
- MICHIGAN**
- Identification of wood energy resources in central Michigan [NASA-CR-158130] 22 p0347 A79-18424
- MICROCLIMATOLOGY**
- Radiation regime of inclined surfaces --- Russian book on solar energy engineering and microclimatology 22 p0282 A79-26353
- MICROCOMPUTERS**
- A digital control system for superconducting magnet 22 p0268 A79-24508
- MICROCRACKS**
- Microcrack technology for geothermal exploration and assessment [PB-290173/4] 22 p0367 A79-21530
- MICROMINIATURIZATION**
- Optimization method of isotopic thermoelectric microgenerator geometry 22 p0260 A79-23613
- MICROPARTICLES**
- Selective absorption of solar energy by ultrafine metal particles 21 p0127 A79-17382
- MICROPROCESSORS**
- A microprocessor based solar controller 21 p0082 A79-14979
- A microprocessor based solar monitoring system 21 p0088 A79-15838
- A microprocessor compatible temperature measuring system --- for solar house energy monitoring 21 p0088 A79-15839
- A microprocessor monitoring system for a solar energy installation 21 p0088 A79-15840
- Low-cost monitoring of solar system performance 21 p0088 A79-15843
- A microprocessor-based control system for solar heating and cooling 21 p0107 A79-16565
- Microprocessor control of a wind turbine generator 22 p0244 A79-21302
- Microprocessor control of a wind turbine generator [NASA-TN-79021] 21 p0195 A79-12548
- MICROSEISMS**
- Study of acoustic and microseismic emissions associated with a hydraulic fracture --- geothermal energy utilization 21 p0076 A79-14744

## MICROSTRUCTURE

- Study of diffusion processes in low-temperature thermopiles --- for solar energy conversion  
21 p0054 A79-13290
- The dependence of optical properties on the structural composition of solar absorbers - Gold black  
22 p0242 A79-21162
- Structure and bonding in metal hydrides  
22 p0247 A79-21679
- Structural studies of hydrides by neutron diffraction  
22 p0248 A79-21681
- Hydrides of rare earth-nickel compounds - Structure and formation enthalpies  
22 p0250 A79-21697
- Microstructure dependence of the optical properties of solar-absorbing black chrome  
22 p0256 A79-22858
- The iron-titanium - hydrogen system: A transmission electron microscope /TEM/ study  
22 p0285 A79-26947
- Microstructural characterization of a black chrome solar selective absorber  
22 p0294 A79-28151

## MICROWAVE ANTENNAS

- Microwave phased array design considerations for SPS --- Solar Powered Satellites  
21 p0003 A79-10031
- Large active retrodirective arrays for solar power satellites  
21 p0107 A79-16604
- Attitude and pointing control system for the microwave antenna of the solar power satellite  
21 p0113 A79-16739
- MICROWAVE OSCILLATORS
- The advanced thermionic converter with microwave power as an auxiliary ionization source  
21 p0153 A79-18470

## MICROWAVE TRANSMISSION

- A microwave power transmission system for space satellite power  
21 p0002 A79-10025
- Environmental considerations for the microwave beam from a solar power satellite  
21 p0003 A79-10030
- A 5-GWe nuclear satellite power system conceptual design  
21 p0003 A79-10033
- Solar power satellite developments [AAS PAPER 78-022]  
21 p0035 A79-11558
- Technology and development requirements of the solar power satellite  
21 p0046 A79-12267
- An aperture-augmented prototype power satellite  
21 p0046 A79-12268
- SPS microwave subsystem potential impacts and benefits --- environmental and societal effects of Solar Power System construction and operation  
21 p0107 A79-16603
- A search for space energy alternatives  
21 p0108 A79-16608
- Design considerations for solar power satellites  
21 p0113 A79-16738
- A development strategy for the solar power satellite [AAS PAPER 78-154]  
22 p0243 A79-21266
- Solar power satellites - The laser option  
22 p0284 A79-26599
- Status of the SPS concept development and evaluation program --- Solar Power Satellite  
22 p0326 A79-31919
- Solar Power Satellite systems definition  
22 p0326 A79-31920
- A review of some critical aspects of satellite power systems  
22 p0326 A79-31921
- Preliminary assessment of the environmental impacts of the Satellite Power System /SPS/  
22 p0326 A79-31922
- Future large space systems opportunities: A case for space-to-space power? --- spacecraft power supplies microwave and laser transmission  
21 p0169 A79-10095
- Achievable flatness in a large microwave power antenna study [NASA-CR-151831]  
21 p0171 A79-10272
- Satellite Power System (SPS) environmental impacts, preliminary assessment [NASA-CR-157952]  
21 p0196 A79-12557

- Satellite Power System (SPS) microwave subsystem impacts and benefits [NASA-CR-157951]  
21 p0196 A79-12558
- Initial assessment: Electromagnetic compatibility aspects of proposed SPS Microwave Power Transmission System (MPTS) operations [FNL-2482]  
21 p0202 A79-13252
- Microwave power transmitting phased array antenna research project [NASA-CR-157843]  
21 p0202 A79-13263
- Satellite Power Systems (SPS) concept definition study. Volume 6: SPS technology requirements and verification [NASA-CR-150685]  
21 p0225 A79-15140
- Microwave systems analysis, solar power satellite --- alignment of the antenna array [NASA-CR-160091]  
22 p0337 A79-16892
- Solar Power Satellite (SPS) pilot beam and communication link subsystem investigation study, phase 1 --- ionospheric propagation, radio frequency interference, and microwave transmission [NASA-CR-161161]  
22 p0345 A79-17896

## MICROWAVES

- Coal desulfurization using microwave energy [PB-285880/1]  
21 p0216 A79-14243

## MILITARY AIR FACILITIES

- Solar assisted heat pump study for heating of military facilities [AD-A058626]  
21 p0206 A79-13506

## MILITARY AIRCRAFT

- Shale oil - The answer to the jet fuel availability question [SAE PAPER 781027]  
22 p0274 A79-25900
- Very large vehicles - To be or --- aircraft design concepts  
22 p0306 A79-30484
- Large-vehicle concepts --- aircraft design  
22 p0306 A79-30485

## MILITARY OPERATIONS

- Military needs for orbital power  
21 p0169 A79-10127
- Satellite Power System (SPS) military applications [NASA-CR-158109]  
22 p0337 A79-16895

## MILITARY TECHNOLOGY

- Militarized thermoelectric power sources  
21 p0027 A79-10227
- The potential of liquid hydrogen as a military aircraft fuel  
22 p0238 A79-20773
- Air Force applications of lightweight superconducting machinery --- in airborne power sources  
22 p0290 A79-27666

## Army energy plan

- [AD-A057987]  
21 p0197 A79-12562
- Satellite Power System (SPS) military applications [NASA-CR-158109]  
22 p0337 A79-16895

## MILITARY VEHICLES

- High sulfur fuel effects in a two-cycle high speed army diesel engine [AD-A059534]  
21 p0216 A79-14232

## MIM (SEMICONDUCTORS)

- Merocyanine organic solar cells  
21 p0165 A79-20216

## MINERAL DEPOSITS

- Methane utilization from coalbeds for power generation [TID-28408]  
22 p0352 A79-19171

## MINERAL EXPLORATION

- Permeability enhancement using explosive techniques --- georesources recovery techniques  
21 p0005 A79-10048
- Future programs and prospects for resource exploration from space by the year 2000 [AAS PAPER 78-182]  
22 p0243 A79-21275
- Energy and remote sensing applications  
22 p0255 A79-22516
- Remote sensing use in hydraulic planification in Mexico  
22 p0255 A79-22522
- Surtrace - An airborne geochemical system --- for earth surface micro-layer exploration  
22 p0255 A79-22557
- Bureau of Mines research 1977. A summary of significant results in mining, metallurgy, and mineral economics [PB-284743/2]  
21 p0217 A79-14521

# MINES (EXCAVATIONS)

# SUBJECT INDEX

Application of LANDSAT data and digital image processing --- Ruhr Valley, Germany  
[E79-10102] 22 p0339 N79-17291

## MINES (EXCAVATIONS)

Instrumentation development for in situ coal gasification 21 p0006 A79-10053  
Remote sensing and mine subsidence in Pennsylvania 22 p0303 A79-29936

## MINICOMPUTERS

Moderate cost, calculator-based data acquisition for solar HVAC systems 21 p0088 A79-15837  
Design of the data acquisition system at Solar One --- home energy monitoring via minicomputers 21 p0088 A79-15841  
A minicomputer based data acquisition and analysis systems for vertical axis wind turbine testing 21 p0144 A79-17617  
Real time computer control of 5 megawatts of solar thermal energy 21 p0144 A79-17621

## MINING

An approach to automated longwall mining [AIAA PAPER 79-0532] 22 p0274 A79-25871  
Bureau of Mines research 1977. A summary of significant results in mining, metallurgy, and mineral economics [PB-284743/2] 21 p0217 N79-14521  
Reservoir ecosystems and western coal development in the upper Missouri River Basin [PB-287363/6] 22 p0339 N79-17309  
Methods for the control of environmental damage caused by mining energy producing materials 22 p0347 N79-18359  
Source assessment: Open mining of coal. State of the Art [PB-288497/1] 22 p0353 N79-19429

## MINNESOTA

Biomass utilization in Minnesota [PB-282531/3] 21 p0171 N79-10241

## MINORITY CARRIERS

Effect of grain boundaries in silicon on minority-carrier diffusion length and solar-cell efficiency 22 p0252 A79-21807  
Effects of minority-carrier storage at the interface states on the fill factor of m.i.s. solar cells 22 p0313 A79-31347

## MIRRORS

Measurement of heat loss from a heat receiver assembly of a Fixed Mirror Solar Concentrator 21 p0020 A79-10166  
Specular mirrors for solar energy application 21 p0034 A79-11147  
Comparison of the solar concentrating properties of truncated hexagonal, pyramidal and circular cones 21 p0043 A79-11974  
Large, lightweight, replicated mirrors 21 p0043 A79-11976  
Mechanical deflection analysis of diamond turned reflective optics --- for laser fusion 21 p0083 A79-15143  
Orbiting mirrors for terrestrial energy supply 21 p0108 A79-16605  
Performance of optimal geometry three step compound wedge stationary concentrator --- solar collector using flat side mirrors 21 p0134 A79-17438  
A cost effective total energy system using a faceted mirror sunlight concentrator and high intensity solar cells 21 p0135 A79-17446  
Manufacture of curved glass mirrors for linear concentrators 21 p0136 A79-17459  
Optimal geometries for one- and two-faced symmetric side-wall booster mirrors --- for solar collectors 21 p0149 A79-18019  
Fixed mirror solar concentrator for power generation [GA-A-14883] 21 p0187 N79-11526

## MIS (SEMICONDUCTORS)

Interface properties and stability of Schottky barriers and MIS solar cells 21 p0123 A79-17342

Photovoltaic effect in metal-insulator-semiconductor structure 21 p0123 A79-17343

Reliability studies on MIS solar cells 21 p0148 A79-17950  
The interfacial layer in MIS amorphous silicon solar cells 22 p0258 A79-23039

The short-wavelength response of MIS solar cells 22 p0273 A79-25748  
Effects of minority-carrier storage at the interface states on the fill factor of m.i.s. solar cells 22 p0313 A79-31347

Silicon Schottky photovoltaic diodes for solar energy conversion [PB-283998/3] 21 p0198 N79-12572

## MISSILE CONTROL

Nickel-zinc battery for aircraft and missile applications [AD-A059295] 21 p0220 N79-14561

## MISSION PLANNING

Roll-out solar arrays - Candidate power sources for future space missions [IAP PAPER 78-39] 21 p0034 A79-11216  
Overview of future programs - USA --- manned orbital space missions 21 p0116 A79-177275

An evolutionary solar power satellite program [AAS PAPER 78-153] 22 p0243 A79-21265  
A development strategy for the solar power satellite [AAS PAPER 78-154] 22 p0243 A79-21266

Future programs and prospects for resource exploration from space by the year 2000 [AAS PAPER 78-182] 22 p0243 A79-21275

Symposium on the Future of Space Science and Space Applications [GPO-23-876] 21 p0224 N79-15105

Statement of Ivan Bekey, Director of Advanced Mission Studies, Aerospace Corporation 21 p0224 N79-15107

Statement of Doctor Krafft A. Ehrliche, President, Space Global, La Jolla, California 21 p0224 N79-15108

Statement of Doctor Klaus Heiss, President, ECON, Incorporated, Princeton, New Jersey 21 p0224 N79-15110

Statement of Doctor Robert A. Prosch, Administrator, National Aeronautics and Space Administration 21 p0224 N79-15111

OAST Space Theme Workshop. Volume 1: Summary report. 1: Introduction. 2: General observations and some key findings. 3: Follow-on activity. Quick-look comments and working papers [NASA-TM-80001] 21 p0224 N79-15113

OAST Space Theme Workshop. Volume 2: Theme summary. 1: Space power (no. 7). A. Theme statement. B. 26 April 1976 presentation. C. Summary. D. Initiative action [NASA-TM-80002] 21 p0225 N79-15114

OAST Space Theme Workshop. Volume 3: Working group summary. 6: Power (P-2). A. Statement. B. Technology needs (form 1). C. Priority assessment (form 2) [NASA-TM-80013] 21 p0225 N79-15125

Manned remote work station development article [NASA-CR-151871] 22 p0330 N79-16057

The 25 kW power module evolution study. Part 3: Conceptual designs for power module evolution. Volume 2: Program plans [NASA-CR-161146] 22 p0345 N79-17890

Authorizing appropriations to the National Aeronautics and Space Administration [H-REPT-96-52] 22 p0364 N79-20928

## MISSOURI

Regional air pollution study: Heat emission inventory [PB-284081/7] 21 p0200 N79-12602

LPG in Missouri [PB-286329/8] 21 p0230 N79-15421

Applying NASA remote sensing data to geologically related regional planning problems in Tennessee [E79-10095] 22 p0339 N79-17289

## MODERATION (ENERGY ABSORPTION)

Perspective on the fusion-fission energy concept 21 p0095 A79-15913



## MODULAR INTEGRATED UTILITY SYSTEM

A technical analysis for cogeneration systems with potential applications in twelve California industrial plants --- energy saving heat-electricity utility systems

21 p0011 A79-10099

International project catalog of modular integrated utility systems

[PB-283477/8] 21 p0190 A79-11544

Committee on the Challenges of Modern Society  
Rational use of Energy Pilot Study Modular Integrated Utility Systems Project. Volume 1: Description, activities, and products

[PB-283428/1] 21 p0190 A79-11549

Committee on the challenges of modern society  
rational use of energy pilot study modular integrated utility system project. Volume 2: Minutes of project meeting

[PB-283429/9] 21 p0191 A79-11558

Fluidized bed gas turbine experimental unit for MHD applications  
[ORNL/HUD/MHD-32]

21 p0220 A79-14564

## MODULES

Solar system modeling using a modular approach with generalized programs for working fluid properties

22 p0266 A79-24310

Block 4 solar cell module design and test specification for residential applications  
[NASA-CR-158117]

22 p0348 A79-18453

Solar cell module assembly jig  
[NASA-CASE-IGS-00829-1]

22 p0353 A79-19447

## MOJAVE DESERT (CA)

A probabilistic model of insolation for the Mojave desert-area

21 p0076 A79-14766

## MOLDS

Wind-turbine-generator rotor-blade concepts with low-cost potential

22 p0240 A79-20828

## MOLECULAR CHAINS

Combustion chemistry of chain hydrocarbons

21 p0052 A79-12986

## MOLECULAR IONS

Preparation and ionic conductivity of H3O<sup>+</sup>/beta alumina --- for hydrogen-oxygen fuel cells

21 p0040 A79-11821

## MOLTEN SALT ELECTROLYTES

Migrational polarization in high-current density molten salt electrochemical devices

21 p0039 A79-11811

Electrochemistry of lithium/metal sulfide and calcium/metal sulfide cells using molten salt electrolytes

21 p0040 A79-11832

Molten-carbonate CO2 concentrator - Preliminary experiments  
[ASME PAPER 78-PN-2]

21 p0048 A79-12551

Performance of molten salt sodium/beta-alumina/SbCl3 cells

22 p0245 A79-21479

Steady-state composition profiles in mixed molten salt electrochemical devices. II - Molten carbonate fuel cell analogs

22 p0305 A79-30333

## MOLTEN SALTS

Molten carbonate fuel cell systems - Status and potential

21 p0039 A79-11817

Effects of sintering on porous fuel cell electrodes

21 p0039 A79-11818

Partial processes and transport parameters in molten carbonate fuel cell operation

21 p0040 A79-11819

Alternative central receiver solar power plant using salt as a heat transfer and storage medium  
[AIChE PAPER 78-1753]

21 p0060 A79-13855

## MOLYBDENUM

Chemical vapor deposited molybdenum films for use in photothermal conversion

22 p0294 A79-28148

## MOMENTUM THEORY

On the motion of runaway electrons in momentum space --- analysis for multi-component plasma in tokamaks

22 p0291 A79-27880

## MONITORS

Conference on Performance Monitoring Techniques for Evaluation of Solar Heating and Cooling Systems, Washington, D.C., April 3, 4, 1978, Proceedings

21 p0087 A79-15826

Considerations in choosing solar energy monitoring systems

21 p0087 A79-15831

Experience gained and lessons learned from monitoring the solar building, Albuquerque

21 p0088 A79-15833

Instrumentation, data acquisition and monitoring system for an air heating solar system

21 p0088 A79-15836

A microprocessor based solar monitoring system

21 p0088 A79-15838

A microprocessor compatible temperature measuring system --- for solar house energy monitoring

21 p0088 A79-15839

A microprocessor monitoring system for a solar energy installation

21 p0088 A79-15840

Design of the data acquisition system at Solar One --- home energy monitoring via minicomputers

21 p0088 A79-15841

A low cost approach to performance monitoring for the evaluation of a solar domestic hot water system

21 p0088 A79-15842

Low-cost monitoring of solar system performance

21 p0088 A79-15843

An inexpensive multiplexer temperature measuring system for monitoring and evaluation of solar collectors

21 p0089 A79-15847

## MONTE CARLO METHOD

Performance and economic risk evaluation of dispersed solar thermal power systems by Monte Carlo simulation

21 p0020 A79-19153

## MOSSBAUER EFFECT

Mossbauer spectroscopy of iron in coal and coal hydrogenation products

22 p0282 A79-26464

## MOTOR VEHICLES

The storage and release of hydrogen from magnesium alloy hydrides for vehicular applications

22 p0249 A79-21688

## MULTIENGINE VEHICLES

Comparative automotive engine operation when fueled with ethanol and methanol  
[HCF/W1737-01]

21 p0201 A79-13189

## MULTILAYER INSULATION

Helting multifoil insulation for KIPS emergency cooling --- Kilowatt Isotope Power System

21 p0023 A79-10191

## MULTIPLEXING

An inexpensive multiplexer temperature measuring system for monitoring and evaluation of solar collectors

21 p0089 A79-15847

## MULTIPOLES

Magnetic multipole line-cusp plasma generator for neutral beam injectors

22 p0238 A79-20746

## MULTISPECTRAL BAND SCANNERS

Application of multispectral scanner data to the study of an abandoned surface coal mine  
[NASA-TN-78912]

21 p0204 A79-13472

## MULTISPECTRAL PHOTOGRAPHY

Landsat - Developing techniques and applications in mineral and petroleum exploration

21 p0111 A79-16725

## MUTATIONS

Energy-related pollutants in the environment: The use of short-term for mutagenicity in the isolation and identification of biohazards  
[CONF-780121-2]

21 p0192 A79-11568

## N

## N-TYPE SEMICONDUCTORS

Iron oxide semiconductor electrodes in photoassisted electrolysis of water

21 p0037 A79-11781

n-CdS/n-GaAs photoanode --- electrochemical solar cells

21 p0037 A79-11784

## NASA PROGRAMS

## SUBJECT INDEX

- Comprehensive thermoelectric properties of n- and p-type 78a/o Si - 22a/o Ge alloy 22 p0259 A79-23604
- Method of producing a p-type or n-type alloy for direct thermoelectric energy conversion 22 p0260 A79-23615
- Some effects of leg surface heat losses on the performance of a p-n type thermoelectric generator 22 p0260 A79-23616
- NASA PROGRAMS**
- NASA's thermionic technology program 21 p0026 A79-10217
- Technology for aircraft energy efficiency 21 p0066 A79-14136
- Large wind turbine generators --- NASA program status and potential costs 21 p0092 A79-15881
- Space power for space 21 p0100 A79-16143
- A technology program for large area space systems 21 p0100 A79-16145
- Overview of future programs - USA --- manned orbital space missions 21 p0116 A79-17275
- How to tap NASA developed technology 21 p0164 A79-19896
- Engine technology for production turbofan engines 22 p0270 A79-24827
- Some perspectives on research into the biological response to non-ionizing electromagnetic radiation --- relation to SETI, SPS, and other government projects 22 p0271 A79-24879
- The NASA Aircraft Energy Efficiency program 22 p0325 A79-31912
- Solar Power Satellite systems definition 22 p0326 A79-31920
- OAST space power technology program 21 p0169 A79-10123
- Satellite power systems program 21 p0169 A79-10128
- NASA research on general aviation power plants [NASA-TN-79031] 21 p0194 A79-12086
- PY 1978 scientific and technical reports, articles, papers, and presentations --- bibliography [NASA-TN-78203] 21 p0214 A79-13915
- National Aeronautics and Space Act of 1958, as amended, and related legislation [GPO-34-175] 21 p0214 A79-13932
- Symposium on the Future of Space Science and Space Applications [GPO-23-876] 21 p0224 A79-15105
- Statement of Ivan Bekey, Director of Advanced Mission Studies, Aerospace Corporation 21 p0224 A79-15107
- Statement of Doctor Robert A. Prosch, Administrator, National Aeronautics and Space Administration 21 p0224 A79-15111
- OAST Space Theme Workshop. Volume 1: Summary report. 1: Introduction. 2: General observations and some key findings. 3: Follow-on activity. Quick-look comments and working papers [NASA-TN-80001] 21 p0224 A79-15113
- OAST Space Theme Workshop. Volume 3: Working group summary. 6: Power (P-2). A. Statement. B. Technology needs (form 1). C. Priority assessment (form 2) [NASA-TN-80013] 21 p0225 A79-15125
- United States civilian space programs: An overview [GPO-35-823] 21 p0232 A79-15815
- General aviation energy-conservation research programs 22 p0329 A79-15963
- LSA Low-cost Solar Array project [NASA-CR-158250] 22 p0355 A79-19462
- Tests of NASA ceramic thermal barrier coating for gas-turbine engines [NASA-TN-79116] 22 p0357 A79-20118
- Authorizing appropriations to the National Aeronautics and Space Administration [H-REPT-96-52] 22 p0364 A79-20928
- NASA's OAST program: An overview 22 p0370 A79-21574
- Effort of the Jet Propulsion Laboratory 22 p0370 A79-21575
- Lewis Research Center program 22 p0370 A79-21576
- Accelerated test program 22 p0370 A79-21577
- NATURAL GAS**
- Aspects of pulsating combustion --- gaseous methane burning system 21 p0008 A79-10072
- Performance of a Stirling engine powered heat activated heat pump --- gas heating-cooling system 21 p0011 A79-10098
- Study of the applicability of the geochemistry of gases in geothermal prospecting 21 p0075 A79-14736
- Shock-tube measurements of induction and post-induction rates for low-Btu gas mixtures --- derived from shale oil retorting and coal gasification 21 p0083 A79-15245
- Production and use of low and medium Btu gas 21 p0095 A79-15912
- Transport fuels from natural gas 22 p0292 A79-27897
- Environmentally induced cracking of natural gas and liquid pipelines. Volume 2: Appendices A and B [PB-282924/0] 21 p0181 A79-11446
- Environmentally induced cracking of natural gas and liquid pipelines. Volume 1: Technical report [PB-282923/2] 21 p0181 A79-11447
- Potential producibility and recovery of natural gas from geopressured aquifers of the Cenozoic sediments of the Gulf Coast Basin [PE-2025-3] 21 p0192 A79-11607
- Proceedings of Energy Resource 5th Conference [PB-286246/4] 21 p0230 A79-15423
- GAO work involving title V of the Energy Policy and Conservation Act of 1975 [PB-286400/7] 21 p0230 A79-15424
- Northern Alaska hydrocarbon resources [PB-287394/1] 22 p0332 A79-16342
- Tests of Wisconsin S12D engine running on natural gas with addition of carbon dioxide [AD-A058486] 22 p0339 A79-17230
- Direction of gas supply research in the US 22 p0340 A79-17320
- Late diagenetic indicators of buried oil and gas. 2: Direct detection experiment at Cement and Garza fields, Oklahoma and Texas, using enhanced LANDSAT 1 and 2 images [E79-10099] 22 p0347 A79-18373
- Method of utilization from coalbeds for power generation [TID-28408] 22 p0352 A79-19171
- Economic impacts of a transition to higher oil prices --- estimation and budget allocations [BWL-50871] 22 p0364 A79-20927
- NAVIGATION SATELLITES**
- The NTS-2 satellite solar cell experiment 21 p0001 A79-10016
- NAVY**
- US Navy energy plan and program, 1978 [AD-A058054] 21 p0197 A79-12560
- Naval Air Systems Command-Naval Research Laboratory Workshop on Basic Research Needs for Synthetic Hydrocarbon Jet Aircraft Fuels [AD-A060081] 21 p0216 A79-14235
- NEODYMIUM LASERS**
- Frequency doubling of a solar pumped Nd:YAG laser 21 p0044 A79-12062
- DOE programs in material development for fusion laser systems 21 p0082 A79-15137
- Requirements and new materials for fusion laser systems 21 p0082 A79-15138
- A survey of laser glasses --- for fusion studies 21 p0083 A79-15140
- Performance of the short-pulse oscillators for Argus and Shiva 21 p0083 A79-15171
- NEON**
- Measurements of compressed core density of laser-imploded targets by x-ray continuum-edge shift 21 p0154 A79-18479

**NETHERLANDS**

The performance of the heating system in the solar house of the Eindhoven University of Technology  
22 p0276 A79-25938

**NETWORK ANALYSIS**

Application of the superposition principle to solar-cell analysis  
22 p0300 A79-29426

**NEUTRAL BEAMS**

Development of energetic neutral beams to the megawatt power level for controlled thermonuclear research  
21 p0054 A79-13439

Magnetic multipole line-cusp plasma generator for neutral beam injectors  
22 p0238 A79-20746

Evidence for neutral-beam-injected oxygen impurities in 2XIIIB --- mirror confined plasma  
22 p0292 A79-27887

**NEUTRAL GASES**

Heat transport near the wall of a tokamak reactor  
22 p0324 A79-31764

**NEUTRAL PARTICLES**

A simple neutral density profile calculation for tokamaks with lambda sub wfp much smaller than a  
22 p0255 A79-22379

Recombination-induced neutral-particle flux in tokamaks  
22 p0291 A79-27877

**NEUTRON DIFFRACTION**

Structural studies of hydrides by neutron diffraction  
22 p0248 A79-21681

Hydrogen storage in FeTi - Surface segregation and its catalytic effect on hydrogenation and structural studies by means of neutron diffraction  
22 p0312 A79-31156

**NEUTRON EMISSION**

Optimum properties of a noncylindrical pinch --- neutron energy yield in fusion plasma  
22 p0244 A79-21433

**NEUTRON IRRADIATION**

Materials problems and possible solutions for near term tokamak fusion reactors  
21 p0079 A79-14790

**NEW MEXICO**

Toward assessing the geothermal potential of the Jemez Mountains volcanic complex: A telluric-magnetotelluric survey  
[LA-7656-MS] 22 p0358 A79-20458

A time domain survey of the Los Alamos Region, New Mexico  
[LA-7657-MS] 22 p0365 A79-21248

**NEW ZEALAND**

Energy scenarios: Supplementary studies  
[NP-23292] 21 p0211 A79-13543

**NICKEL**

Catalytic effect of Ni and K2CO2 in the gasification of carbon and coal  
22 p0364 A79-21215

**NICKEL ALLOYS**

Hot corrosion of Ni-base turbine alloys in atmospheres in coal-conversion systems  
22 p0288 A79-27395

**NICKEL CADMIUM BATTERIES**

Nickel-cadmium battery reconditioning and long term performance in geosynchronous orbit spacecraft  
21 p0029 A79-10242

Mathematics of coiling in cylindrical electrochemical cells - The theory of a spiral bounded by two circles and its application to the spiral-wound nickel-cadmium cell  
22 p0246 A79-21489

Study of the characteristics of Ni-Cd storage batteries for space applications  
22 p0304 A79-30207

Some fatigue characteristics of nickel battery plague  
[AD-A060370] 21 p0230 A79-15415

The 100 kW space station --- regenerative fuel cells and nickel hydrogen and nickel cadmium batteries for solar arrays  
22 p0371 A79-21603

**NICKEL COATINGS**

Spectral selective properties of black chrome and nickel electrodeposited coatings for solar absorber  
21 p0127 A79-17383

Field performance of certain selective and neutral surfaces in solar collectors  
21 p0131 A79-17417

**NICKEL COMPOUNDS**

Hydrogen storage by LaNi5 - Fundamentals and applications  
21 p0038 A79-11803

Absorption of hydrogen by the intermetallics NdNi5 and LaNi4Cu and a correlation of cell volumes and desorption pressures  
21 p0038 A79-11804

Localization and diffusion of hydrogen in lanthanum-nickel compounds  
22 p0248 A79-21682

Some applications of LaNi5-type hydrides --- using reversible reaction with hydrogen working fluid for heat storage  
22 p0249 A79-21694

Metal hydride electrodes for electrochemical energy storage  
22 p0249 A79-21695

Hydrides of rare earth-nickel compounds - Structure and formation enthalpies  
22 p0250 A79-21697

**NICKEL HYDROGEN BATTERIES**

The 100 kW space station --- regenerative fuel cells and nickel hydrogen and nickel cadmium batteries for solar arrays  
22 p0371 A79-21603

Multistack nickel-hydrogen units  
22 p0371 A79-21610

**NICKEL OXIDES**

Electrochemical-ellipsometric studies of oxide films formed on nickel during oxygen evolution  
21 p0038 A79-11799

Design and cost study of a nickel-iron oxide battery for electric vehicles. Volume 2: Public report  
[ANL-K-3723-VOL-1] 21 p0222 A79-14579

**NICKEL ZINC BATTERIES**

Nickel-zinc vs. silver-zinc battery - A comparative study of baseline characteristics  
21 p0009 A79-10083

Rapid, efficient charging of lead-acid and nickel-zinc traction cells --- for electric vehicles  
21 p0009 A79-10084

An improved method for analysis of hydroxide and carbonate in alkaline electrolytes containing zinc  
21 p0035 A79-11546

The zinc electrode in sealed alkaline cells  
21 p0040 A79-11823

Nickel-zinc battery for aircraft and missile applications  
[AD-A059295] 21 p0220 A79-14561

**NIGHT**

An analytical investigation of the performance of solar collectors as nighttime heat radiators in airconditioning cycles  
[NASA-CR-3111] 22 p0363 A79-20519

**NITINOL ALLOYS**

Nitinol thermodynamic state surfaces --- heat engine material  
21 p0045 A79-12264

**NITRIC OXIDE**

Kinetics of nitric oxide formation in combustion  
21 p0053 A79-12989

**NITRIDES**

/Si/Al-GaAs polymer-semiconductor solar cells  
21 p0154 A79-18504

**NITROGEN COMPOUNDS**

The fate of fuel nitrogen - Implications for combustor design and operation  
21 p0080 A79-14927

**NITROGEN DIOXIDE**

Emissions of nitrogen dioxide from a large gas-turbine power station  
21 p0152 A79-18344

**NITROGEN OXIDES**

Controlling NOx from a coal-fired MHD process  
21 p0017 A79-10139

Investigating combustion turbine burner performance with coal derived liquids having high fuel bound nitrogen  
[ASME PAPER 78-GT-126] 21 p0033 A79-10791

Simultaneous nitrogen oxides and sulfur dioxide removal by absorption-reduction scrubbing  
21 p0066 A79-14125

- Combustion modifications for the control of air pollutant emissions from coal fired utility boilers  
[ASME PAPER 78-WA/APC-7] 21 p0158 A79-19738
- Low-NOx combustion concepts for advanced power generation systems firing low-Btu gas  
[PB-282983/6] 21 p0178 A79-10610
- Nitrogen oxide air pollution. Volume 2, part 1: Control technology. A bibliography with abstracts  
[NTIS/PS-78/0971/8] 21 p0199 A79-12591
- Nitrogen oxide air pollution. Part 3: Atmospheric chemistry. A bibliography with abstracts  
[NTIS/PS-78/0973/4] 21 p0199 A79-12593
- Combustion research on the fate of fuel-nitrogen under conditions of pulverized coal combustion  
[PB-286208/4] 21 p0232 A79-15474
- NITROGEN TETROXIDE**  
Using N2O4 in a solar gas-turbine plant 21 p0167 A79-20357
- NOISE POLLUTION**  
Noise-control needs in the developing energy technologies  
[COO-4389-1] 21 p0213 A79-13569
- Environmental conservation concerns in transportation: Energy, noise, and air quality  
[PB-286550/9] 21 p0232 A79-15868
- NONAQUEOUS ELECTROLYTES**  
Electrochemical characteristics of ZrO2-Y2O3 solid electrolytes for fuel cells 21 p0039 A79-11813
- The secondary lithium electrode in non-aqueous electrolytes - Some problems, some solutions 21 p0041 A79-11838
- Low voltage behavior of lithium/metal dichalcogenide topochemical cells 22 p0286 A79-26995
- NONCONDENSABLE GASES**  
Effect of noncondensable gases on geothermal power generation 21 p0015 A79-10125
- NONDESTRUCTIVE TESTS**  
Evaluation of methods for analyzing silver-zinc cells 21 p0010 A79-10085
- Detection of internal defects in a liquid natural 8F82g2g tank by use of infrared thermography 21 p0048 A79-12507
- NONEQUILIBRIUM IONIZATION**  
Effects of position of output electrodes in entrance region of open-cycle diagonal type MHD generator 21 p0153 A79-18468
- Effect of finite boundary layer on the ionization instability in non-equilibrium MHD generators 21 p0153 A79-18469
- NONEQUILIBRIUM PLASMAS**  
The ion fly-wheel effect on the electro-thermal instability in non-equilibrium MHD Hall disc generators 21 p0046 A79-12270
- On the flow of a conducting fluid between parallel disks with a transverse magnetic field. I - A theoretical investigation on a nonequilibrium plasma flow as a compressible inviscid fluid 21 p0156 A79-19445
- NONEQUILIBRIUM THERMODYNAMICS**  
Quasi-equilibrium Air Standard heat balanced cycle analysis 21 p0028 A79-10232
- NONLINEAR EQUATIONS**  
Non-linear numerical algorithms for studying tearing modes --- in tokamaks 22 p0257 A79-22981
- Parametric decay of lower hybrid waves in a plasma - Effect of ion nonlinearity --- in tokamaks 22 p0269 A79-24814
- Integral invariants and quasi-MHD nonlinear dissipation --- in magnetized toroidal plasmas 22 p0270 A79-24862
- NONLINEAR OPTICS**  
Review of theories for predicting n2 in glasses and crystals --- refractive index of fusion laser materials 21 p0083 A79-15139
- Generation of the new coherent radiation by harmonic conversion and nonlinear mixing for certain applications --- optical interactions 21 p0111 A79-16639
- Effects of nonlinear decay of backscattered light on the anomalous reflectivity --- in laser plasmas 22 p0310 A79-30742
- NORTH ATLANTIC TREATY ORGANIZATION (NATO)**  
The AGARD propulsion and energetics panel, 1952-1977 [AGARD-AR-111] 22 p0337 A79-16848
- NOSE CONES**  
Test and development of ceramic combustors, stators, nose cones, and rotor tip shrouds 21 p0049 A79-12821
- NOZZLE DESIGN**  
Flow modeling of an atmospheric pressure, entrained-type coal gasifier 22 p0280 A79-26188
- NUCLEAR DEVICES**  
Nuclear Science Symposium, 25th, and Symposium on Nuclear Power Systems, 10th, Washington, D.C., October 18-20, 1978, Proceedings 22 p0297 A79-28901
- NUCLEAR ELECTRIC POWER GENERATION**  
Energy conversion engineering --- Book 22 p0302 A79-29575
- Coal and nuclear: A comparison of the cost of generating baseload electricity by region [PB-289585/2] 22 p0355 A79-19469
- NUCLEAR ELECTRIC PROPULSION**  
NASA's thermionic technology program 21 p0026 A79-10217
- Power coupling alternatives for the NEP thermionic power system [NASA-CR-158372] 22 p0367 A79-21547
- NUCLEAR ENERGY**  
A systems study of our energy problems 21 p0074 A79-14704
- Materials problems in solar, nuclear and storage of energy 21 p0094 A79-15901
- Energy for the long run - Fission or fusion 22 p0256 A79-22760
- Nuclear Science Symposium, 25th, and Symposium on Nuclear Power Systems, 10th, Washington, D.C., October 18-20, 1978, Proceedings 22 p0297 A79-28901
- Nuclear power today and tomorrow 22 p0340 A79-17317
- NUCLEAR FISSION**  
Perspectives on energy: Issues, ideas, and environmental dilemmas /2nd edition/ --- Book 21 p0147 A79-17646
- Controlled thermonuclear fusion 22 p0287 A79-27339
- NUCLEAR FUEL REPROCESSING**  
Proliferation-resistant nuclear fuel cycles [ORNL/TN-6392] 21 p0214 A79-13849
- NUCLEAR FUELS**  
Fuel technology and the environment --- nuclear reactor caused radiation effects and transmutation 21 p0079 A79-14787
- Development of cryogenic targets for laser fusion 21 p0085 A79-15333
- Cryogenic pellets for laser-fusion research - Theoretical and practical considerations 21 p0085 A79-15334
- Point-contact conduction-cooling technique and apparatus for cryogenic laser fusion pellets 21 p0085 A79-15335
- Pellet X-ray spectra for laser fusion reactor designs 22 p0291 A79-27878
- Proliferation-resistant nuclear fuel cycles [ORNL/TN-6392] 21 p0214 A79-13849
- Current and projected fuel costs --- electric rate schedules and projected costs of fossil, synthetic, and nuclear fuels 21 p0218 A79-14532
- Nuclear power today and tomorrow 22 p0340 A79-17317
- NUCLEAR FUSION**  
A new method for producing cryogenic laser fusion targets 21 p0085 A79-15332
- Controlled thermonuclear fusion 22 p0287 A79-27339
- Parametric requirements for noncircular Tokamak commercial fusion plants [GA-A-14876] 21 p0214 A79-13871
- Parametric requirements for noncircular Tokamak commercial fusion plants [GA-A-14946] 21 p0214 A79-13872

# SUBJECT INDEX

# MUTATION DAMPERS

## NUCLEAR MAGNETIC RESONANCE

- Nuclear magnetic resonance studies of metal hydrides  
22 p0248 A79-21683
- NMR studies of hydrogen relaxation and diffusion  
in TiFeH/x/ and TiFe/1-y/Hn/y/H/x/  
22 p0248 A79-21684
- Electronic structure and physical properties of  
Ti-H and Zr-H using NMR  
22 p0248 A79-21685

## NUCLEAR POWER PLANTS

- A 5-GWe nuclear satellite power system conceptual  
design  
21 p0003 A79-10033
- Radioisotope-powered free-piston Stirling engine  
for space applications  
[IAP PAPER 78-42]  
21 p0034 A79-11217
- Comparison of nuclear and coal power plants using  
Net Energy Analysis  
21 p0073 A79-14692
- The nuclear closed-cycle gas turbine /GT-BTGR/ - A  
utility power plant for the year 2000  
[AIAA PAPER 79-0191]  
21 p0157 A79-19590
- Substitute natural gas from coal using  
high-temperature reactor heat - Project  
'Prototype Plant Nuclear Process Heat'  
22 p0264 A79-23827
- Parametric requirements for noncircular Tokamak  
commercial fusion plants  
[GA-A-14876]  
21 p0214 A79-13871
- Parametric requirements for noncircular Tokamak  
commercial fusion plants  
[GA-A-14946]  
21 p0214 A79-13872
- Use of waste heat from thermal electric power  
plants and nuclear power plants to heat  
greenhouses  
[ORNL-TR-4483]  
21 p0221 A79-14574
- Integrated safeguards information System (ISIS),  
executive summary --- nuclear power plant and  
fissionable materials security  
[PB-286869/3]  
21 p0223 A79-14934
- OAST Space Theme Workshop. Volume 2: Theme  
summary. 1: Space power (no. 7). A. Theme  
statement. B. 26 April 1976 presentation. C.  
Summary. D. Initiative action  
[NASA-TM-80002]  
21 p0225 A79-15114

## NUCLEAR PUMPED LASERS

- Progress in nuclear-pumped lasers  
21 p0110 A79-16627

## NUCLEAR REACTIONS

- Nuclear characteristics of D-D fusion reactor  
blankets - Technical data  
21 p0162 A79-19826

## NUCLEAR REACTORS

- Fuel technology and the environment --- nuclear  
reactor caused radiation effects and transmutation  
21 p0079 A79-14787
- Overview of the magnetic fusion energy development  
and technology program  
[HCP/T3073-01]  
21 p0193 A79-11887

## NUCLEAR RESEARCH

- Fusion-Fission Energy Systems  
21 p0017 A79-10144
- Doublet III design and construction --- Tokamak  
fusion research device  
21 p0018 A79-10145
- The Mirror Fusion Test Facility /MFTF/  
21 p0018 A79-10147
- CO2-laser fusion  
21 p0018 A79-10150
- Progress in tokamak experimental research in the  
Soviet Union  
21 p0069 A79-14455
- The mirror machine program in the USA ---  
controlled fusion experiments and research  
facilities  
21 p0070 A79-14461
- Progress in laser-fusion research  
21 p0070 A79-14464
- Generation and applications of high power ion  
beams to fusion research  
21 p0070 A79-14466
- Fusion reactor problems --- plasma confinement and  
interface engineering  
21 p0071 A79-14468
- Predemonstration fusion devices - Research and  
development needs  
21 p0078 A79-14785

## NUMERICAL ANALYSIS

- Performance studies of a finned heat pipe latent  
thermal energy storage system  
21 p0121 A79-17325
- An analysis of a cylindrical parabolic focussing  
collector for distributed collector power system  
21 p0134 A79-17442
- The analysis of heat transfer with and without  
condensation in a heat pipe heat exchanger  
[ASME PAPER 78-WA/HT-59]  
21 p0161 A79-19824
- Numerical computation of the loss coefficients for  
evacuated cylindrical collector receiver tubes  
[ASME PAPER 78-WA/SOL-3]  
21 p0162 A79-19836
- Subsonic flow in the channel of an MHD-generator  
21 p0167 A79-20413
- Optimum properties of a noncylindrical pinch ---  
neutron energy yield in fusion plasma  
22 p0244 A79-21433
- Mathematics of coiling in cylindrical  
electrochemical cells - The theory of a spiral  
bounded by two circles and its application to  
the spiral-wound nickel-cadmium cell  
22 p0246 A79-21489
- Combustion of hydrogen in a supersonic flow in a  
channel in the presence of a pseudodiscontinuity  
22 p0324 A79-31845
- Stored energy calculation: The state of the art  
[PNL-2581]  
21 p0210 A79-13541
- Application of solar technology to today's energy  
needs, volume 2 --- systems analysis and  
analytical methods  
[OTA-E-77-VOL-2]  
21 p0218 A79-14530
- Analytical methods  
21 p0218 A79-14531

## NUMERICAL CONTROL

- Computer aided optimization of integrated coal  
gasification combined cycle power plants  
21 p0008 A79-10075
- Five MW solar thermal test facility heliostat  
focus and alignment system  
21 p0043 A79-11972
- The use of computer-controlled data acquisition  
systems in determining solar heating and cooling  
system performance  
21 p0088 A79-15834
- A microprocessor based solar monitoring system  
21 p0088 A79-15838
- A microprocessor monitoring system for a solar  
energy installation  
21 p0088 A79-15840
- Design of the data acquisition system at Solar One  
--- home energy monitoring via minicomputers  
21 p0088 A79-15841
- Low-cost monitoring of solar system performance  
21 p0088 A79-15843
- A microprocessor-based control system for solar  
heating and cooling  
21 p0107 A79-16565
- Real time computer control of 5 megawatts of solar  
thermal energy  
21 p0144 A79-17621
- Microprocessor control of a wind turbine generator  
22 p0244 A79-21302
- A digital control system for superconducting magnet  
22 p0268 A79-24508
- A computerized reporting and monitoring system for  
geothermal energy development  
[LBL-8483]  
22 p0369 A79-21555

## NUMERICAL WEATHER FORECASTING

- System performance predictions for solar cooling  
using regional stochastic weather models  
22 p0264 A79-23781

## RUSSELL NUMBER

- Experimental measurements and correlations of  
Russell number for MHD high temperature air  
preheaters  
[ASME PAPER 78-WA/HT-22]  
21 p0161 A79-19809
- Natural convection heat transfer in small and  
moderate aspect ratio enclosures - An  
application to flat plate collectors  
22 p0281 A79-26206

## MUTATION DAMPERS

- Spatial oscillations of a solid body carrying a  
low-power flywheel motor --- dual spin  
spacecraft motion control  
21 p0148 A79-17792

## OCEAN MODELS

A numerical model investigation of tidal phenomena in the Bay of Fundy and Gulf of Maine

22 p0323 A79-31554

## OCEAN SURFACE

Wave energy conversion in a random sea

21 p0030 A79-10252

A wave activated electric generator --- waterwave energy conversion

22 p0288 A79-27389

## OCEAN THERMAL ENERGY CONVERSION

The National Program for Solar Energy

21 p0072 A79-14688

An introduction to ocean thermal energy conversion /OTEC/ power plants

21 p0091 A79-15869

OTEC program status and plans

21 p0094 A79-15902

Market penetration for OTEC

21 p0094 A79-15903

Ocean thermal energy conversion; Proceedings of the Energy Technology Conference and Exhibition, Houston, Tex., November 6-9, 1978

21 p0100 A79-16245

Some early and recent novel OTEC systems

21 p0100 A79-16246

An overview of the U.S. OTEC development program

21 p0100 A79-16247

OTEC power systems

21 p0101 A79-16248

Capital cost system optimization of OTEC power modules

21 p0101 A79-16249

Advances in ocean engineering aspects of ocean thermal energy conversion

21 p0101 A79-16250

Power cables to accommodate the motions of an OTEC plant

21 p0101 A79-16251

Alternative forms of energy transmission from OTEC plants

21 p0141 A79-17505

Heat exchangers for Ocean Thermal Energy Conversion plants

21 p0142 A79-17506

OTEC in Europe --- economic aspects of Ocean Thermal Energy Conversion

21 p0152 A79-18109

Principles of design and construction for marine structures for wave/tidal/ocean thermal energy

21 p0152 A79-18114

Conceptual design of large heat exchangers for ocean thermal energy conversion

21 p0161 A79-19813

Development of compact heat exchangers for Ocean Thermal Energy Conversion /OTEC/ systems

21 p0161 A79-19815

The use of heat exchangers with THERMOEXCEL's tubing in ocean thermal energy power plants

21 p0162 A79-19825

Fluids engineering in advanced energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978

22 p0278 A79-2617

Working fluids and turbines for OTEC power systems

22 p0280 A79-26192

Environmental considerations for siting an ocean thermal conversion early ocean testing platform at four proposed areas

22 p0287 A79-27377

Optimum power plant capacity of ocean-based ocean thermal energy conversion systems

22 p0297 A79-28922

An ocean thermal difference power plant in the Canadian Arctic

22 p0318 A79-31415

Net energy analysis of five energy systems [ORAU/IEA(R)-77-12]

21 p0174 A79-10534

Environmental Development Plan (EDP): Ocean thermal energy conversion, 1977

21 p0188 A79-11531

Renewable ocean energy sources. Part 1: Ocean thermal energy conversion

21 p0191 A79-11556

[PB-283104/8]

Renewable ocean energy sources. Part 1: Working papers. Ocean thermal energy conversion [PB-283103/0] 21 p0191 A79-11557  
Energy analyses applied to ocean thermal energy conversion and an offshore wind power system 22 p0353 A79-19442

## OCEANOGRAPHIC PARAMETERS

Oceans '78: The ocean challenge; Proceedings of the Fourth Annual Combined Conference, Washington, D.C., September 6-8, 1978 22 p0287 A79-27376

## OCEANOGRAPHY

ERDA'S oceanographic program for the mid-Atlantic coastal region --- impact of offshore energy development on coastal ecology [BNL-24016] 21 p0192 A79-11641

## OFFSHORE ENERGY SOURCES

Salinity power station at the Swedish west-coast - Possibilities and energy-price for a 200 MW-plant 21 p0077 A79-14772

Useful power from ocean waves

21 p0077 A79-14773

OTEC program status and plans

21 p0094 A79-15902

Ocean energy unlimited --- water wave conversion 21 p0095 A79-15908

Ocean thermal energy conversion; Proceedings of the Energy Technology Conference and Exhibition, Houston, Tex., November 6-9, 1978 21 p0100 A79-16245

Some early and recent novel OTEC systems

21 p0100 A79-16246

An overview of the U.S. OTEC development program

21 p0100 A79-16247

Power plant systems based on solar energy --- powered by sea water evaporation-produced osmotic pressure head mechanical energy 21 p0142 A79-17508

OTEC in Europe --- economic aspects of Ocean Thermal Energy Conversion

21 p0152 A79-18109

Oceans '78: The ocean challenge; Proceedings of the Fourth Annual Combined Conference, Washington, D.C., September 6-8, 1978 22 p0287 A79-27376

Technology considerations in the design of a commercial offshore energy conversion /OTEC/ plant 22 p0288 A79-27378

A wave activated electric generator --- waterwave energy conversion 22 p0288 A79-27389

Energy from sea waves - System optimization by diffraction theory 22 p0288 A79-27390

The use of ocean energy - A hydrostatic motor 22 p0288 A79-27391

Some recent developments in wind and ocean power systems 22 p0303 A79-29797

Off-shore multi-MW size wind turbine system development is the key to cost-effective wind energy for Sweden 22 p0326 A79-31917

Feasibility study of transporting offshore OTEC-produced energy to shore by thermal media. Project 8980 [DSE/2426-19] 21 p0174 A79-10535

ERDA'S oceanographic program for the mid-Atlantic coastal region --- impact of offshore energy development on coastal ecology [BNL-24016] 21 p0192 A79-11641

Cooking with offshore oil: A handbook for California local government --- regional planning [PB-288656/2] 22 p0331 A79-16140

Environmental effects of offshore oil production 22 p0336 A79-16389

## OFFSHORE PLATFORMS

OTEC power systems 21 p0101 A79-16248

Advances in ocean engineering aspects of ocean thermal energy conversion 21 p0101 A79-16250

Power cables to accommodate the motions of an OTEC plant 21 p0101 A79-16251

Environmental considerations for siting an ocean thermal conversion early ocean testing platform at four proposed areas 22 p0287 A79-27377

## SUBJECT INDEX

## OPTICAL MEASUREMENT

- Technology considerations in the design of a commercial offshore energy conversion /OTEC/ plant  
22 p0288 A79-27378
- Energy/environment 1978: Symposium on energy development impacts  
[PB-288578/8] 22 p0355 B79-19470
- OHIO RIVER (US)  
Energy and environment: An intergovernmental perspective  
[PB-283733/4] 21 p0198 B79-12575
- OHMIC DISSIPATION  
Ohmic heating experiments in the W VII A stellarator  
21 p0069 A79-14458  
Ohmic heating experiments in the L-2 stellarator  
21 p0070 A79-14460  
Empirical scaling laws for energy confinement in ohmically-heated tokamaks  
22 p0253 A79-22240
- OIL EXPLORATION  
Future programs and prospects for resource exploration from space by the year 2000  
[AAS PAPER 78-182] 22 p0243 A79-21275
- OIL FIELDS  
Outlook for world oil into the 21st century with emphasis on the period to 1990  
[EPRI-2A-745] 21 p0181 B79-11454  
Environmental effects of offshore oil production  
22 p0336 B79-16389  
Late diagenetic indicators of buried oil and gas.  
2: Direct detection experiment at Cement and Garza fields, Oklahoma and Texas, using enhanced LANDSAT 1 and 2 images  
[E79-10099] 22 p0347 B79-18373
- OIL POLLUTION  
Environmental impacts of industrial energy systems in the coastal zone  
21 p0075 A79-14722  
Managing oil and gas activities in coastal environments  
[PB-283677/3] 21 p0199 B79-12576  
Oil pollution reports, volume 5, number 2 --- bibliographies  
[PB-287071/5] 22 p0336 B79-16437  
Environmental assessment of the Alaskan Continental Shelf. Volume 1: Biological studies  
[PB-289154/7] 22 p0344 B79-17366  
Environmental assessment of the Alaskan Continental Shelf. Volume 2: Biological studies  
[PB-289155/4] 22 p0344 B79-17367  
Environmental assessment of the Alaskan Continental Shelf. Volume 3: Biological studies  
[PB-289156/2] 22 p0344 B79-17368  
Marine biological effects of OCS petroleum development  
[PB-288935/0] 22 p0344 B79-17374
- OIL RECOVERY  
Oil recovery from a Utah tar sand deposit by in situ combustion  
21 p0004 A79-10043  
Prerrefining true in situ shale oil  
21 p0004 A79-10044  
Jet fuels from shale oil - A near term technology  
21 p0005 A79-10045  
Colorado's oil-shale resource for vertical modified in-situ processes  
21 p0005 A79-10046  
Comparison of shale oils from different sources produced by controlled-state retort  
21 p0005 A79-10047  
Permeability enhancement using explosive techniques --- georesources recovery techniques  
21 p0005 A79-10048  
Recovery of oil from oil shale - An overall technological perspective  
21 p0073 A79-14698  
Factors affecting bitumen recovery by the hot water process  
22 p0282 A79-26463  
Energy and Technology Review, June 1978 --- composite materials for flywheels, shale oil recovery, and seismic safety at nuclear power plants  
[UCRL-52000-78-6] 21 p0215 B79-14168  
Analytical modelling of oil recovery by steam injection  
22 p0358 B79-20434
- OILS  
Specific heat variations in oil energy storage media and their economic implications  
[SAND-78-8672] 21 p0189 B79-11537  
Coal liquefaction support studies. Task 1: Heat of reaction of hydrogen with coal slurries.  
Task 2: Heat transfer coefficient  
[ANL/CER/PE-77-5] 21 p0216 B79-14242
- OKLAHOMA  
Late diagenetic indicators of buried oil and gas.  
2: Direct detection experiment at Cement and Garza fields, Oklahoma and Texas, using enhanced LANDSAT 1 and 2 images  
[E79-10099] 22 p0347 B79-18373
- ONBOARD EQUIPMENT  
A critical review and evaluation of published electric-vehicle performance data  
21 p0009 A79-10081
- OPEN CHANNEL FLOW  
Technical support for open-cycle MHD program  
[ANL-MHD-78-8] 22 p0361 B79-20507
- OPERATING TEMPERATURE  
Operating experience at the DOE/Sandia midtemperature Solar Systems Test Facility  
21 p0022 A79-10182  
Growth of refractory oxide layers by electrochemical vapor deposition /EVD/ at elevated temperatures --- for fuel cells  
21 p0039 A79-11812  
A comparison among various flat plate collectors with honeycomb structures  
21 p0128 A79-17392  
Optimum design parameters of horizontal coaxial cylinders for a solar energy collector  
21 p0134 A79-17444  
Solar collector storage panel  
[ASME PAPER 78-WA/SOL-12] 21 p0163 A79-19844
- OPERATIONAL HAZARDS  
Health maintenance and health surveillance considerations for an SPS space construction base community  
[AAS PAPER 78-176] 22 p0243 A79-21273  
Differential scanning calorimetry studies of possible explosion-causing mixtures in Li/SO<sub>2</sub> cells  
22 p0246 A79-21487
- OPERATIONAL PROBLEMS  
History and development of condensers at the Geysers geothermal power plant  
[ASME PAPER 78-JPGC-PWR-18] 21 p0150 A79-18099  
Design and operating experience of the cryogenic system of the U.S. SCMS as incorporated into the bypass loop of the U-25 MHD generator facility --- Superconducting Magnet System  
22 p0235 A79-20532  
Environmental factors affecting the installation and operation of gas turbine engines in agricultural aircraft  
[SAE PAPER 781010] 22 p0274 A79-25892  
Transport fuels from natural gas  
22 p0292 A79-27897
- OPERATIONS RESEARCH  
Control problems of the magnetohydrodynamic electrical power generation in power station cooperating with electrical power system  
22 p0303 A79-29798  
Utility operational experience on the NASA/DOE MOD-0A 200-kW wind turbine  
[NASA-TS-79084] 22 p0360 B79-20494
- OPTICAL COMMUNICATION  
Optical coatings for a space laser communications system  
22 p0292 A79-28028
- OPTICAL EQUIPMENT  
Optics in adverse environments; Proceedings of the Seminar, San Diego, Calif., August 25, 26, 1977  
21 p0044 A79-12037  
Historical review of adaptive optics technology  
21 p0114 A79-17171
- OPTICAL FILTERS  
On the use of grating or mesh selective filters to increase the efficiency of flat plate solar collectors  
21 p0127 A79-17380
- OPTICAL MEASUREMENT  
Optical evaluation techniques for reflecting solar concentrators  
21 p0043 A79-11971

## OPTICAL PROPERTIES

- Effects of weather and pollution on incident solar energy - Basic measurements leading to computer models 21 p0065 A79-14117
- Measurement techniques for solar cells [PB-287519/3] 22 p0343 N79-17352
- ### OPTICAL PROPERTIES
- An approximate equation for predicting the solar transmittance of transparent honeycombs 21 p0042 A79-11877
- Requirements and new materials for fusion laser systems 21 p0082 A79-15138
- A survey of laser glasses --- for fusion studies 21 p0083 A79-15140
- Analysis of optical behavior and collector performance of a solar concentrator 21 p0107 A79-16545
- Transparent conducting coatings for solar cells 21 p0124 A79-17350
- Selective coatings for solar energy conversion 21 p0126 A79-17376
- Selective absorption of solar energy by ultrafine metal particles 21 p0127 A79-17382
- Solar concentrators --- using cheap refractive lenses 21 p0136 A79-17455
- Effect of physical properties of a flat plate solar collector cover on efficiency calculations - Simplifying hypotheses 21 p0164 A79-19949
- Suitable optical materials for solar collector applications 22 p0239 A79-20823
- The dependence of optical properties on the structural composition of solar absorbers - Gold black 22 p0242 A79-21162
- Microstructure dependence of the optical properties of solar-absorbing black chrome 22 p0256 A79-22858
- First-order design variables for concentrating solar collectors 22 p0293 A79-28141
- A flat plate multiple pass solar collector using aqueous optical properties 22 p0293 A79-28144
- Optical analysis of solar facility heliostats 22 p0296 A79-28360
- Development of surfaces optically suitable for flat solar panels [NASA-CR-150831] 21 p0173 N79-10522
- Optical coatings for solar cells and solar collectors. Citations from the NTIS data base [NTIS/PS-78/1341/3] 22 p0350 N79-18465
- Optical coatings for solar cells and solar collectors. Citations from the Engineering index data base [NTIS/PS-78/1342/1] 22 p0350 N79-18466
- ### OPTICAL PUMPING
- Frequency doubling of a solar pumped Nd:YAG laser 21 p0044 A79-12062
- Systems efficiency and specific mass estimates for direct and indirect solar-pumped closed-cycle high-energy lasers in space 21 p0110 A79-16623
- A new concept for solar pumped lasers 21 p0110 A79-16624
- Optical coatings for a space laser communications system 22 p0292 A79-28028
- Blackbody optical pumping of carbon dioxide laser mixtures 21 p0203 N79-13343
- ### OPTICAL REFLECTION
- General principles of multielement concentrating system design --- solar collectors 21 p0054 A79-13291
- Reflecting horizontal collector 21 p0128 A79-17395
- Enhanced power generation by optical solar reflectors on geostationary spinners 22 p0272 A79-25138
- Cavity-type surfaces for solar collectors 22 p0283 A79-26497
- ### OPTIMAL CONTROL
- A microprocessor based solar controller 21 p0082 A79-14979

## SUBJECT INDEX

- Operation and control of wind-electric systems 21 p0086 A79-15575
- Optimizing solar energy systems using continuous flow control 21 p0138 A79-17477
- Optimal control of on-board and station flywheel storage for rail transit systems 21 p0148 A79-17822
- An optimal standard for solar heating systems [ASHE PAPER 78-WA/DSC-19] 21 p0159 A79-19765
- Optimal control of on-board and station flywheel storage for rail transit systems [ASHE PAPER 78-WA/DSC-32] 21 p0159 A79-19771
- Control problems of the magnetohydrodynamic electrical power generation in power station cooperating with electrical power system 22 p0303 A79-29798
- Control strategy for a variable-speed wind energy conversion system 22 p0303 A79-29800
- The application of optimal control theory hybrid electric transit systems [AD-A059365] 21 p0220 N79-14559
- ### OPTIMIZATION
- Computer aided optimization of integrated coal gasification combined cycle power plants 21 p0008 A79-10075
- Optimum design conditions for a power plant at a vapor dominated geothermal resource, Pacific Gas and Electric's The Geysers Power Plant Unit 16 21 p0014 A79-10121
- Economic optimization of the coal-fired MHD Steam Power Plant 21 p0016 A79-10134
- Cost minimization of photovoltaic power supplies 21 p0021 A79-10171
- Development of gas turbine performance seeking logic [ASHE PAPER 78-GT-13] 21 p0031 A79-10257
- A vacuum solar thermal collector with optimal concentration 21 p0043 A79-11970
- Optimum selection of a wind turbine generator system [ATAA PAPER 78-1774] 21 p0062 A79-13871
- Optimal sizing of solar collectors by the method of relative areas 21 p0066 A79-14263
- Design optimization for solar array of multiple collector types 21 p0071 A79-14677
- Investigation of the optimal use of geothermal waters for the heating of several types of dwelling in various European climates 21 p0075 A79-14739
- Determining optimal angles of nonconvex solar battery panel mounting 21 p0080 A79-14837
- Capital cost system optimization of OTEC power modules 21 p0101 A79-16249
- A study for optimum use of metallic plates for thermal storage in solar processes 21 p0122 A79-17331
- Cost effective optimum design of solar air heaters 21 p0127 A79-17386
- Optimum collection geometries for copper tube - copper sheet flat plate collectors 21 p0127 A79-17387
- Optimal profile of solar energy collectors 21 p0130 A79-17408
- Solar thermal collectors using planar reflector 21 p0131 A79-17442
- Solar collector optimization 21 p0132 A79-17418
- Design and optimization of a flat plate collector for cooling application 21 p0132 A79-17419
- Optimising the pitching of tubes in a flat solar collector for increasing the efficiency for use in vapour absorption refrigeration 21 p0132 A79-17422
- Two thermodynamic optima in the design of sensible heat units for energy storage 21 p0150 A79-18091
- Review of optimization and economic evaluation of potential tidal power developments in the Bay of Fundy 21 p0152 A79-18111
- On the optimisation of Trombe wall solar collectors [ASHE PAPER 78-WA/SOL-13] 21 p0163 A79-19845



# SUBJECT INDEX

OSNOSIS

- Universal generator storer curves --- Economic and relative size optimization of solar photovoltaic energy 22 p0238 A79-20799
- Optimization of an ideal thermionic converter 22 p0241 A79-20941
- Optimal decisions for long-term operation of hydropower systems 22 p0245 A79-21473
- Optimization of a diagonal MHD channel 22 p0247 A79-21628
- Optimizing the conversion mode for solar energy 22 p0258 A79-23125
- Optimization method of isotopic thermoelectric microgenerator geometry 22 p0260 A79-23613
- Optimum collector slope for residential heating in adverse climates 22 p0263 A79-23761
- Design and optimisation of an absorption refrigeration system operated by solar energy 22 p0285 A79-26819
- Optimality criteria in the compensation of the longitudinal boundary effect in induction MHD machines 22 p0298 A79-29277
- Structural cost optimization of photovoltaic central power station modules and support structure [ASME PAPER 79-SOL-17] 22 p0309 A79-30551
- ORBIT CALCULATION**
- Particle orbits in field-reversed mirrors --- for plasma confinement in fusion reactor 22 p0253 A79-22239
- Alpha transport and blistering in tokamaks 22 p0253 A79-22243
- Single-particle behaviour in plasmas 22 p0257 A79-22977
- ORBIT PERTURBATION**
- Spatial oscillations of a solid body carrying a low-power flywheel motor --- dual spin spacecraft motion control 21 p0148 A79-17792
- ORBIT TRANSFER VEHICLES**
- Satellite Power Systems (SPS) concept definition study. Volume 5: Transportation and operations analysis --- heavy lift launch and orbit transfer vehicles for orbital assembly [NASA-CR-158067] 21 p0225 A79-15139
- ORBITAL ASSEMBLY**
- Construction of a 10GWe solar power satellite 21 p0003 A79-10029
- Space platforms for building large space structures 21 p0032 A79-10511
- Structures for solar power satellites 21 p0032 A79-10513
- On-orbit fabrication and assembly of large space structural subsystems [IAF PAPER 78-192] 21 p0035 A79-11288
- Technology and development requirements of the solar power satellite 21 p0046 A79-12267
- Health maintenance and health surveillance considerations for an SPS space construction base community [AAS PAPER 78-176] 22 p0243 A79-21273
- Satellite Power Systems (SPS) concept definition study. Volume 5: Transportation and operations analysis --- heavy lift launch and orbit transfer vehicles for orbital assembly [NASA-CR-158067] 21 p0225 A79-15139
- ORBITAL MECHANICS**
- New design verification aspects of large flexible solar arrays [IAF PAPER 78-217] 21 p0035 A79-11298
- ORBITAL SPACE STATIONS**
- Space platforms for building large space structures 21 p0032 A79-10511
- Overview of future programs - USA --- manned orbital space missions 21 p0116 A79-17275
- Military needs for orbital power 21 p0169 A79-10127
- ORBITAL WORKERS**
- Manned remote work station development article [NASA-CR-151871] 22 p0330 A79-16057
- ORBITER PROJECT**
- The 25 kW power module updated baseline system --- for space transportation system payloads [NASA-TN-78212] 21 p0226 A79-15247
- OREGON**
- Amended Oregon State energy conservation plan, 1978 Prepared in response to the Energy Policy and Conservation Act of 1975 (PL 94-163), and the Energy Conservation and Production Act of 1976 (PL 94-385) [PB-286078/1] 21 p0231 A79-15430
- ORGANIC CHEMISTRY**
- Organic geochemical studies on kerogen precursors in recently deposited algal mats and oozes 21 p0031 A79-10419
- ORGANIC COMPOUNDS**
- The anaerobic attached film expanded bed reactor for the treatment of dilute organic wastes 22 p0356 A79-19928
- ORGANIC LIQUIDS**
- Hydrocarbon working fluid and operating conditions selection for the conventional geothermal binary cycle 21 p0015 A79-10124
- Liquid mixture excess volumes and total vapor pressures using a magnetic suspension densimeter with compositions determined by chromatographic analysis Methane plus ethane 21 p0085 A79-15324
- Use of organic fluids in solar turbines 22 p0269 A79-24621
- ORGANIC WASTES (FUEL CONVERSION)**
- The Garrett Energy Research biomass gasification process 21 p0004 A79-10037
- Liquid fuels from biomass [AIAA PAPER 78-1781] 21 p0063 A79-13876
- Source emissions factors for refuse derived fuels 21 p0082 A79-15084
- Coupled heat and organic wastes stream pollution 21 p0086 A79-15602
- Biomass and wastes as energy resources - 1977 update 21 p0091 A79-15868
- Industrial wastes to energy 21 p0096 A79-15916
- Energy from urban waste 21 p0096 A79-15917
- Co-disposal of sewage sludge using refuse-derived fuel 21 p0097 A79-16098
- Urban wastes as an energy source 21 p0115 A79-17220
- Energy through solar aided bio-gas systems 21 p0125 A79-17367
- Tests of various coals, coal-oil mixtures and refuse derived fuels in an experimental test facility [ASME PAPER 78-WA/APC-12] 21 p0158 A79-19741
- Conversion of biomass materials into gaseous products, phase 1 [SAM/1241-77/1] 21 p0171 A79-10237
- Biomass utilization in Minnesota [PB-282531/3] 21 p0171 A79-10241
- Parameters for legislative consideration of bioconversion technologies [PB-284742/4] 21 p0194 A79-12250
- ORGANIZATIONS**
- Alternative energy sources for Federal Aviation Administration facilities [AD-A058681] 21 p0196 A79-12555
- ORIFICE FLOW**
- Measured air flow rates through microorifices and flow prediction capability [PB-286868/5] 21 p0217 A79-14344
- OSCILLATING CYLINDERS**
- A theory for wave-power absorption by two independently oscillating bodies 21 p0151 A79-18103
- OSCILLATING FLOW**
- Review of liquid piston pumps and their operation with solar energy [ASME PAPER 79-SOL-4] 22 p0308 A79-30542
- OSNOSIS**
- Assessment of the potential of generating power from aqueous saline solutions by means of Osno-Hydro Power systems 21 p0016 A79-10133

- Power plant systems based on solar energy ---  
powered by sea water evaporation-produced  
osmotic pressure head mechanical energy  
21 p0192 A79-17508
- The use of wave powered systems for desalination -  
A new opportunity --- seawater pumping for  
reverse osmosis  
21 p0151 A79-18108
- OSO-8**  
Orbiting Solar Observatory /OSO-8/ solar panel  
design and in-orbit performance  
21 p0001 A79-10017
- OTTO CYCLE**  
The Otto-engine-equivalent vehicle concept  
[NASA-CR-157840]  
21 p0203 A79-13370
- OUTER SPACE TREATY**  
Solar energy and the 'Common Heritage of Mankind'  
--- international agreements regarding usage  
[IAF PAPER 78-SI-45]  
21 p0035 A79-11356
- OUTPUT**  
Effect of solar cell parameter variation on array  
power output  
[SAND-78-0917C]  
21 p0188 A79-11527
- OXIDATION**  
The anodic oxidation of ethyleneglycol at  
platinum, gold and Pt/Au-alloys in alkaline  
solution --- fuel cell electrocatalysis  
21 p0037 A79-11795
- Combustion chemistry of chain hydrocarbons  
21 p0052 A79-12986
- The oxidation of sulfur dioxide to sulfate  
aerosols in the plume of a coal-fired power plant  
21 p0076 A79-14757
- Energy storage using the reversible oxidation of  
barium oxide  
22 p0242 A79-21169
- Oxidation of SO<sub>2</sub> on the surface of fly ash  
particles under low relative humidity conditions  
22 p0277 A79-26038
- OXIDATION RESISTANCE**  
Selective coatings for aluminum and steel solar  
absorbers  
21 p0058 A79-13647
- OXIDATION-REDUCTION REACTIONS**  
On the mechanism of the electrocatalytic oxygen  
reduction with particular regard to metal chelates  
--- in fuel cell electrodes  
21 p0038 A79-11808
- Supply of reactants for Redox bulk energy storage  
systems  
[NASA-TM-78995]  
21 p0183 A79-11479
- OXIDE FILMS**  
Electrochemical-ellipsometric studies of oxide  
films formed on nickel during oxygen evolution  
21 p0038 A79-11799
- Photovoltaic effect in  
metal-insulator-semiconductor structure  
21 p0123 A79-17343
- Transparent conducting coatings for solar cells  
21 p0124 A79-17350
- OXIDIZERS**  
Evaluation of the use of oxygen as oxidant in  
fossil fuel fired open cycle MHD-steam energy  
conversion processes  
22 p0353 A79-19444
- OXYGEN**  
Study of the interaction of H<sub>2</sub>O and O<sub>2</sub> with the  
surface of TiO<sub>2</sub> by electron stimulated  
desorption and Auger and characteristic loss  
spectroscopies  
21 p0037 A79-11793
- O<sub>2</sub> reduction kinetics in concentrated acids --- in  
fuel cells  
21 p0038 A79-11809
- The effects of wall temperature on light  
impurities in Alcator --- tokamak device  
22 p0313 A79-31188
- Evaluation of the use of oxygen as oxidant in  
fossil fuel fired open cycle MHD-steam energy  
conversion processes  
22 p0353 A79-19444
- OXYGEN IONS**  
Evidence for neutral-beam-injected oxygen  
impurities in 2XII-B --- mirror confined plasma  
22 p0292 A79-27887
- OZONE**  
On the depletion of ambient ozone by a rural  
coal-fired power plant near Portage, Wisconsin  
21 p0082 A79-15052

## P

**P-I-N JUNCTIONS**

- Characterization of electron and ion current flow  
in very large aspect-ratio terawatt diodes  
employing heated and unheated anodes  
21 p0154 A79-18480
- Study of photoelectric characteristics of  
photocells made from high-resistivity silicon  
22 p0296 A79-28666

**P-N JUNCTIONS**

- Role of the diode exponential factor in CdS solar  
cells  
21 p0123 A79-17348
- Response of p-n junction solar cells to  
concentrated sunlight and partial illumination  
21 p0124 A79-17353
- Response of a solar cell to intense and nonuniform  
illumination when used with solar concentrators  
21 p0125 A79-17357
- Sensitivity calculations for the design of solar  
cells. I - Schottky barrier devices  
21 p0125 A79-17360
- Characteristics of silicon photoconverters with  
inversion layer  
21 p0166 A79-20349
- Temperature dependence of photovoltaic solar  
energy conversion for GaAs homojunction solar cell  
22 p0256 A79-22768
- A two-junction cascade solar-cell structure  
22 p0256 A79-22856
- High-efficiency thin-film polycrystalline-silicon  
solar cells  
22 p0273 A79-25744
- A better approach to the evaluation of the series  
resistance of solar cells  
22 p0281 A79-26242
- An investigation of dark current and photocurrent  
superposition in photovoltaic devices  
22 p0291 A79-27871
- Back wall solar cell  
[NASA-CASE-LEW-12236-2]  
21 p0217 A79-14528
- P-TYPE SEMICONDUCTORS**  
Suppression of vaporization in  
copper-silver-selenide thermoelectric materials  
21 p0027 A79-10224
- Comprehensive thermoelectric properties of n- and  
p-type 78a/o Si - 22a/o Ge alloy  
22 p0259 A79-23604
- Method of producing a p-type or n-type alloy for  
direct thermoelectric energy conversion  
22 p0260 A79-23615
- Some effects of leg surface heat losses on the  
performance of a p-n type thermoelectric generator  
22 p0260 A79-23616

**PACIFIC NORTHWEST (US)**

- Wind power potential in the Pacific Northwest  
22 p0244 A79-21334
- Region at the crossroads: The Pacific Northwest  
searches for new sources of electric energy  
[PB-284691/3]  
21 p0222 A79-14583

**PACKAGING**

- Status of wraparound contact solar cells and arrays  
--- for spacecraft electric propulsion  
21 p0001 A79-10014

**PALEONTOLOGY**

- Continental geotherms during the Archaean --- heat  
production in ancient earth crust  
22 p0269 A79-24620

**PALLADIUM ALLOYS**

- Electronic states of concentrated Pd-B alloys from  
de Haas-van Alphen measurements  
22 p0248 A79-21686
- High temperature thermodynamics of the solid  
solutions of hydrogen and deuterium in palladium  
and in the Pd/0.9Ag/0.1 alloy  
22 p0249 A79-21689

**PANELS**

- Filon panels - A technical report --- fiberglass  
reinforced plastics for solar collectors  
21 p0031 A79-10403
- Cooling applications of thermic diode panels  
[ASME PAPER 78-WA/SOL-10]  
21 p0163 A79-19842
- A theoretical analysis of solar collector/storage  
panels  
[ASME PAPER 78-WA/SOL-11]  
21 p0163 A79-19843
- Solar collector storage panel  
[ASME PAPER 78-WA/SOL-12]  
21 p0163 A79-19844

# SUBJECT INDEX

# PARTICULATE SAMPLING

- An improved solar panel and method for fabricating the same  
[NASA-CASE-NPO-14490-1] 22 p0348 N79-18445
- PARABOLAS**  
Performance testing of the Hexcel Parabolic Trough Solar Collector  
[SAND-76-0381] 21 p0221 N79-14569
- PARABOLIC REFLECTORS**  
Effects of pointing errors on receiver performance for parabolic dish solar concentrators  
21 p0020 A79-10167  
Transient energy removal in cylindrical parabolic collector systems  
21 p0020 A79-10168  
Performance of evacuated solar collectors with compound parabolic concentrators  
21 p0089 A79-15855  
A compound parabolic concentrator for a high temperature solar collector requiring only twelve tilt adjustments per year  
21 p0134 A79-17439  
Compound parabolic concentrators with non-evacuated receivers - Prototype performance and a larger scale demonstration in a school heating system  
21 p0134 A79-17440  
An analysis of a cylindrical parabolic focussing collector for distributed collector power system  
21 p0134 A79-17442  
Geometrical aspects of a cylindrical parabolic collector  
21 p0134 A79-17443  
Design fabrication and testing of three meter diameter parabolic dish heliostat system  
21 p0135 A79-17447  
Distribution of beam radiation of the receiver plane of a CPC solar concentrator --- Compound Parabolic Concentrators  
21 p0135 A79-17451  
Performance of solar concentrators - A theoretical study  
21 p0135 A79-17453  
Manufacture of curved glass mirrors for linear concentrators  
21 p0136 A79-17459  
Laser ray trace tester for parabolic trough solar collectors  
21 p0144 A79-17619  
A comparison of compound parabolic and simple parabolic concentrating solar collectors  
22 p0262 A79-23754  
A parabolic solar reflector for accurate and economic producibility  
22 p0293 A79-28145  
Analysis of a Cassegrain solar furnace  
22 p0293 A79-28147  
Thermal analysis of black liquid cylindrical parabolic collector  
22 p0295 A79-28354  
Thermal performance evaluation of a flat-plate cylindrical parabolic concentrator and a flat-plate collector  
22 p0317 A79-31408  
Cylindrical parabolic collector optimization for interfacing with steam turbine generators  
22 p0322 A79-31448  
The parabolic concentrating collector: A tutorial  
[NASA-CR-158246] 22 p0359 N79-20491
- PARABOLOID MIRRORS**  
Design, construction, and testing of a Fixed Mirror Solar Concentrator field  
21 p0020 A79-10164  
Optical evaluation techniques for reflecting solar concentrators  
21 p0043 A79-11971  
Nonimaging solar concentrators  
21 p0043 A79-11973  
Facility with sectioned photoreceiver and laser radiator for determining solar radiation concentrator accuracy characteristics  
21 p0054 A79-13292  
Large-aperture radiant solar energy concentrators  
21 p0135 A79-17452  
Shading and spacing in paraboloidal collector arrays  
21 p0150 A79-18025  
Thermal deformations of solar-energy concentrators  
21 p0166 A79-20355
- Sensitivity of slope measurements on parabolic solar mirrors to positioning and alignment of the laser scanner  
[SAND-78-0700] 21 p0185 N79-11496
- PARAFFINS**  
Investigation of physical and chemical properties of phase change materials for space heating/cooling applications  
21 p0120 A79-17319  
Theoretical and experimental analysis of a latent heat storage system --- solar energy absorbers  
21 p0121 A79-17323
- PARALLEL PLATES**  
An interferometric investigation heat transfer in honeycomb solar collector cells  
21 p0129 A79-17398  
Wave-tank experiments on an immersed parallel-plate duct --- for testing performance of sub-sea wave energy converter  
22 p0258 A79-23306
- PARAMETERIZATION**  
Parametric requirements for noncircular Tokamak commercial fusion plants  
[GA-A-14876] 21 p0214 N79-13871  
Parametric requirements for noncircular Tokamak commercial fusion plants  
[GA-A-14946] 21 p0214 N79-13872
- PARTICLE ACCELERATOR TARGETS**  
Fusion power with particle beams  
21 p0034 A79-11121  
A new method for producing cryogenic laser fusion targets  
21 p0085 A79-15332
- PARTICLE ACCELERATORS**  
Fusion power with particle beams  
21 p0034 A79-11121
- PARTICLE BEAMS**  
Fusion power with particle beams  
21 p0034 A79-11121
- PARTICLE COLLISIONS**  
Collisional transport --- particle diffusion and heat transport in tokamak  
21 p0078 A79-14780  
Calculation of the Q factor for a two-component tokamak  
22 p0324 A79-231763
- PARTICLE DIFFUSION**  
Thermophoresis - Enhanced deposition rates in combustion turbine blade passages  
[ASME PAPER 78-WA/GT-1] 21 p0160 A79-19790
- PARTICLE FLUX DENSITY**  
Recombination-induced neutral-particle flux in tokamaks  
22 p0291 A79-27877
- PARTICLE INTERACTIONS**  
Effect of electrode shielding on beamlet-beamlet interaction in multiaperture sources  
21 p0154 A79-18481
- PARTICLE MOTION**  
Single-particle behaviour in plasmas  
22 p0257 A79-22977  
On the motion of runaway electrons in momentum space --- analysis for multi-component plasma in tokamaks  
22 p0291 A79-27880
- PARTICLE SIZE DISTRIBUTION**  
Evaluations of novel particulate control devices  
[PB-283973/6] 21 p0199 N79-12601
- PARTICLE TRAJECTORIES**  
Particle orbits in field-reversed mirrors --- for plasma confinement in fusion reactor  
22 p0253 A79-22239
- PARTICLES**  
Surfactant-assisted liquefaction of particulate carbonaceous substances  
[NASA-CASE-NPO-13904-1] 21 p0179 N79-11152
- PARTICULATE SAMPLING**  
Particulate and sulfur oxide control options for conventional coal combustion  
21 p0092 A79-15883  
The measurement of the sulfuric acid and sulfate content of particulate matter resulting from the combustion of coal and oil  
21 p0156 A79-19219  
Air quality assessment of particulate emissions from diesel-powered vehicles  
[PB-286172/2] 21 p0223 N79-18641

## PASSENGER AIRCRAFT

## SUBJECT INDEX

- Low-sulfur western coal use in existing small and intermediate size boilers --- particulate sampling and combustion efficiency  
[PB-287937/7] 22 p0346 A79-18061
- PASSENGER AIRCRAFT**  
The improved rigid airship --- design characteristics and cost analysis 21 p0086 A79-15572
- PAYLOAD MASS RATIO**  
Systems efficiency and specific mass estimates for direct and indirect solar-pumped closed-cycle high-energy lasers in space 21 p0110 A79-16623
- PELLETS**  
Plasma density measurements on refuelling by solid hydrogen pellets in a rotating plasma 22 p0255 A79-22369  
Pellet X-ray spectra for laser fusion reactor designs 22 p0291 A79-27878
- PENNSYLVANIA**  
Water/energy management and evaluation model for Pennsylvania [PB-287577/1] 22 p0343 A79-17353
- PERFORMANCE**  
Interim performance criteria for solar heating and cooling systems in residential buildings, second edition [PB-289967/2] 22 p0372 A79-21630
- PERFORMANCE PREDICTION**  
Orbiting Solar Observatory /OSO-8/ solar panel design and in-orbit performance 21 p0001 A79-10017  
Intelsat V solar array design and development summary 21 p0002 A79-10018  
Preliminary controller evaluation for the MIRC/CTIU using a mathematical process model --- of Component Test and Integration Unit in fluidized bed combustion 21 p0008 A79-10073  
Thermal modeling of coal-fired MHD plant components 21 p0017 A79-10138  
Performance and economic risk evaluation of dispersed solar thermal power systems by Monte Carlo simulation 21 p0020 A79-10163  
Conversion of a standard single cylinder I.C. engine into a 'gamma' configuration air charged Stirling engine 21 p0024 A79-10202  
Analytical predictions of selenide RTG power degradation 21 p0026 A79-10223  
Modified silicon-germanium alloys with improved performance --- thermoelectric material 21 p0027 A79-10225  
Toroidal Accelerator Rotor Platforms for wind energy conversion 21 p0029 A79-10240  
Ultra-thin silicon solar cells for high performance panel applications 21 p0029 A79-10243  
Asymptotic behaviour as a guide to the long term performance of solar water heating systems 21 p0041 A79-11872  
Predicted performance of heliostats for ERDA's 10 MWe power plant 21 p0044 A79-12045  
Performance prediction methods for horizontal axis wind turbines 21 p0045 A79-12244  
Predicting the performance of passive solar-heated buildings 21 p0063 A79-13899  
Long-term average performance of the Sunpak evacuated-tube collector 21 p0089 A79-15854  
Simple procedure for predicting long term average performance of nontracking and of tracking solar collectors 21 p0091 A79-15873  
A graphical approach to the efficiency of flat-plate collectors 21 p0102 A79-16422  
Performance of vacuum tube solar collector systems 21 p0102 A79-16424
- The El Camino Real Solar Cooling Demonstration Project 21 p0102 A79-16425  
Thermionics and its application to the SPS --- solar power satellite for energy conversion 21 p0109 A79-16616  
Energy and input-output analysis --- for predicting impact on U.S. economy 21 p0115 A79-17223  
Flat plate collector dynamic evaluation 21 p0128 A79-17390  
A parametric investigation on flat-plate solar collectors 21 p0128 A79-17391  
Design, construction and performance of Fresnel lens for solar energy collection 21 p0136 A79-17456  
Solar receiver performance of point focusing collector system [ASME PAPER 78-WA/SOL-5] 21 p0163 A79-19838  
Stochastic predictions of solar cooling system performance [ASME PAPER 78-WA/SOL-16] 21 p0164 A79-19848  
Augmented solar energy collection using different types of planar reflective surfaces - Theoretical calculations and experimental results 22 p0242 A79-21166  
Prediction of the behavior of a solar storage system by means of recurrent stochastic models --- of insolation 22 p0258 A79-23295  
Prediction of the performance of solar heating systems utilizing annual storage 22 p0263 A79-23760  
System performance predictions for solar cooling using regional stochastic weather models 22 p0264 A79-23781  
Modeling, simulation, testing, and measurements for solar energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978 22 p0266 A79-24309  
Modeling two-phase flow in a swirl combustor 22 p0280 A79-26189  
Performance of a hydraulic air compressor for use in Compressed Air Energy Storage power systems 22 p0280 A79-26191  
Performance of combined solar-heat pump systems 22 p0285 A79-26817  
A Markov model of solar energy space and hot water heating systems 22 p0295 A79-28353  
Results and analysis of a round robin test program for liquid-heating flat-plate solar collectors 22 p0295 A79-28356  
Optical analysis of solar facility heliostats 22 p0296 A79-28360  
A flywheel energy storage and conversion system for solar photovoltaic applications [ASME PAPER 79-SOL-1] 22 p0307 A79-30539  
Initial comparison of single cylinder Stirling engine computer model predictions with test results [SAE PAPER 790327] 22 p0315 A79-31368  
Mathematical modelling of passive solar systems 22 p0321 A79-31441  
Measured and modeled passive performance in Montana --- for solar heating and thermal storage 22 p0322 A79-31445  
Performance characteristics of automotive engines in the United States. Second series, report no. 4: 1976 Chevrolet 85 CID (1.4 liters), IV [PB-286294/4] 21 p0227 A79-15308  
Performance characteristics of automotive engines in the United States. Second series, report no. 6: 1976 Nissan diesel 198 CID (3.2 liters), V. I. [PB-286295/1] 21 p0227 A79-15309  
Performance characteristics of automotive engines in the United States. Second series, report no. 7: 1977 Ford 171 CID (2.8 liters), 2V [PB-286296/9] 21 p0227 A79-15310  
Performance characteristics of automotive engines in the United States. First series, report no. 17: 1975 Buick 455 CID (7.5 liters), 4V [PB-286298/5] 21 p0227 A79-15312

# SUBJECT INDEX

# PERFORMANCE TESTS

- Performance characteristics of automotive engines in the United States. First series, report no. 20: 1975 Chevrolet 350 CID (5.7 liters) with dresser variable-area venturi system [PB-286301/7] 21 p0228 A79-15315
- Initial comparison of single cylinder Stirling engine computer model predictions with test results [NASA-TN-79044] 22 p0337 A79-16721
- Phase one/base data for the development of energy performance standard for new buildings. Task report: Building classification [PB-286904/8] 22 p0355 A79-19468
- Simulation of fluidized bed coal combustors [NASA-CR-159529] 22 p0359 A79-20487
- ## PERFORMANCE TESTS
- Pressurized fluidized-bed combustion/component test and integration unit preliminary design report 21 p0008 A79-10076
- Heat exchanger designs for coal-fired fluidized beds 21 p0009 A79-10079
- Evaluation of methods for analyzing silver-zinc cells 21 p0010 A79-10085
- High performance lithium/iron disulfide cells --- for electric vehicle propulsion 21 p0010 A79-10087
- Lithium silicon - Iron sulfide load-leveling and electric vehicle batteries 21 p0010 A79-10088
- Advances in the development of lithium-aluminum/metal sulfide cells for electric-vehicle batteries 21 p0010 A79-10089
- Bipolar lithium/iron disulfide cells --- for electric vehicle propulsion 21 p0010 A79-10090
- Advances in lower cost phosphoric acid fuel cells 21 p0010 A79-10092
- Iron-air batteries for electric vehicles 21 p0011 A79-10094
- Performance of a Stirling engine powered heat activated heat pump --- gas heating-cooling system 21 p0011 A79-10098
- Performance of a 10-MW geothermal energy conversion test facility 21 p0014 A79-10119
- Progress in the testing of materials and design concepts for directly-fired MHD air heater service 21 p0017 A79-10141
- Design, construction, and testing of a Fixed Mirror Solar Concentrator field 21 p0020 A79-10164
- Copper/water axially-grooved heat pipes for RTG applications 21 p0023 A79-10188
- Solar furnace type high power density thermoelectric generator 21 p0027 A79-10229
- Development and testing of the ULP solar array 21 p0029 A79-10245
- Investigating combustion turbine burner performance with coal derived liquids having high fuel bound nitrogen [ASME PAPER 78-GT-126] 21 p0033 A79-10791
- Electric automobiles - Yes 21 p0046 A79-12265
- Performance of a honeycomb type flat plate collector with serpentine tube 21 p0054 A79-13579
- Solar radiation simulation by means of solar simulator for the indoor testing of solar collectors 21 p0055 A79-13620
- Testing the efficiency of solar collectors 21 p0056 A79-13627
- Performance testing of a three ton solar absorption chiller [AIAA PAPER 78-1757] 21 p0060 A79-13858
- Analysis of data user's needs for performance evaluation of solar heating and cooling systems 21 p0087 A79-15827
- Technique and instrumentation for measuring the performance of integrated solar heating/cooling systems 21 p0087 A79-15830
- System performance measurements for a packaged solar space heating system equipped with air-heating collectors 21 p0088 A79-15835
- Performance of evacuated solar collectors with compound parabolic concentrators 21 p0089 A79-15855
- Passive solar heating of buildings [LA-UR-77-1162] 21 p0090 A79-15859
- Testing of solar collectors according to ASHRAE Standard 93-77 21 p0101 A79-16417
- The application of ASHRAE Standard 93-77 to the thermal performance testing of air solar collectors 21 p0102 A79-16423
- Comparative outdoor measurements on flat-plate solar collectors in a metropolitan area in Western Germany 21 p0128 A79-17394
- Comparative performance testing of flat-plate solar water heaters 21 p0130 A79-17405
- Thermal performance testing of flat-plate solar collectors 21 p0130 A79-17407
- The testing procedures of thermal performance of solar collector at Solar Research Lab., G.I.R.I. 21 p0130 A79-17409
- Testing of water-heating collectors according to ASHRAE Standard 93-77 21 p0130 A79-17410
- Field performance of certain selective and neutral surfaces in solar collectors 21 p0131 A79-17417
- Flat plate collector - Experimental studies and design data for India 21 p0132 A79-17425
- A contribution to evaluation of flat-plate solar collectors performance 21 p0133 A79-17427
- Construction and test of a test apparatus for determining the efficiency of solar collectors with the ASE-test method 21 p0134 A79-17436
- Design, fabrication and testing of three meter diameter parabolic dish heliostat system 21 p0135 A79-17447
- Performance of solar heating and cooling systems used in the national solar heating and cooling demonstration program 21 p0139 A79-17478
- Preliminary results from the Georgia Tech 400 kWth Solar Thermal Test Facility 21 p0141 A79-17499
- A minicomputer based data acquisition and analysis systems for vertical axis wind turbine testing 21 p0144 A79-17617
- Performance testing of solar collectors 21 p0155 A79-18875
- Performance evaluation of the New Mexico State University Solar House [ASME PAPER 78-WA/SOL-8] 21 p0163 A79-19840
- Performance of molten salt sodium/beta-alumina/SbCl3 cells 22 p0245 A79-21479
- Wave-tank experiments on an immersed parallel-plate duct --- for testing performance of sub-sea wave energy converter 22 p0258 A79-23306
- Effects of test fluid, flow rate, and flow regime on solar collector thermal performance measurements 22 p0268 A79-24317
- Performance of residential solar heating and cooling system with flat-plate and evacuated tubular collectors - CSU Solar House I 22 p0276 A79-25939
- Performance of a 5 MWt solar steam generator 22 p0288 A79-27399
- Latest developments in sponsored test programs for electric vehicles in France 22 p0302 A79-29497
- A Variable Speed Constant Frequency /VSCF/ wind generator for low power applications 22 p0303 A79-29799
- Field tests of photovoltaic power systems [ASME PAPER 79-SOL-10] 22 p0308 A79-30545

# PERIODIC VARIATIONS

# SUBJECT INDEX

EPRI/TVA pilot electric vehicle demonstration program  
[SAE PAPER 790110] 22 p0314 A79-31357

A solar collector thermal performance test for developmental programs 22 p0317 A79-31413

Passive solar heating - Results from two Saskatchewan residences 22 p0322 A79-31444

Measured and modeled passive performance in Montana --- for solar heating and thermal storage 22 p0322 A79-31445

The first year of solar collector testing at Ontario Research 22 p0322 A79-31450

Studies on solar collector performance at NRC 22 p0322 A79-31451

First year performance data and lessons learned in the NRC 14 house solar demonstration program 22 p0323 A79-31453

US Army/Environmental Projection Agency re-refined engine oil program [AD-A056806] 21 p0171 N79-10216

Indoor test for thermal performance evaluation on the Northrup concentrating solar collector [NASA-CR-150804] 21 p0172 N79-10515

Recommended performance standards for electric and hybrid vehicles [SAN/1335-1] 21 p0195 N79-12450

Provisional flat plate solar collector testing procedures [PB-283721/9] 21 p0198 N79-12571

Comparative automotive engine operation when fueled with ethanol and methanol [BCP/W1737-01] 21 p0201 N79-13189

Brookhaven National Laboratory burner-boiler/furnace efficiency test project. Annual fuel use and efficiency reference manual: hydronic equipment [BNL-50816] 21 p0210 N79-13538

Performance testing of the Hexcel Parabolic Trough Solar Collector [SAND-76-0381] 21 p0221 N79-14569

Performance characteristics of automotive engines in the United States. Second series: Report no. 5 1977 Ford 140 CID (2.3 liters), 2V --- fuel consumption and exhaust gases [PB-286076/5] 21 p0227 N79-15306

Performance characteristics of automotive engines in the United States Third series: Report No. 1 1977 Volvo 130 CID (2.1 liters), P.I. --- fuel consumption and exhaust gases [PB-286077/3] 21 p0227 N79-15307

Performance characteristics of automotive engines in the United States. First series, report no. 18: 1976 Ford CID (6.6 liters), 2V --- fuel consumption and exhaust gases [PB-286299/3] 21 p0227 N79-15313

Thermal performance evaluation of the Solargenics solar collector at outdoor conditions [NASA-CR-150857] 21 p0228 N79-15401

Parametric performance of a turbojet engine combustor using jet A and A diesel fuel [NASA-TM-79089] 22 p0357 N79-20114

Parametric study of the performance of a CDIF 1-B coal-fired MHD generator [ANL-MHD-79-3] 22 p0361 N79-20503

High pressure MHD coal combustors investigation [PB-2706-08] 22 p0362 N79-20510

Experimental verification of a standard test procedure for solar collectors [PB-289912/8] 22 p0372 N79-21632

**PERIODIC VARIATIONS**

Output power variations with solar power satellites 21 p0067 A79-14267

Periodic heating/cooling by solar radiation --- through concrete slab buildings 21 p0140 A79-17491

**PERMEABILITY**

Permeability enhancement using explosive techniques --- georesources recovery techniques 21 p0005 A79-10048

**Perturbation Theory**

Lag damping in autorotation by a perturbation method --- for rigid rotor blades [ARS 78-25] 21 p0152 A79-18151

**PETROLEUM PRODUCTS**

Prerrefining true in situ shale oil 21 p0004 A79-10044

Recovery of oil from oil shale - An overall technological perspective 21 p0073 A79-14698

The department of Defense's alternate energy policy [AD-A058200] 21 p0197 N79-12563

LPG in Missouri [PB-286329/8] 21 p0230 N79-15421

Stimulated biodegradation of waste petroleum 22 p0336 N79-16388

**PETROLOGY**

Thermal conductivity of crystalline rocks associated with energy extraction for hot dry rock geothermal systems 22 p0304 A79-30123

**PHASE CONTROL**

Thyristor controlled rectifier inverting at unity power factor 21 p0033 A79-10898

Automatic phase control in solar power satellite systems [NASA-CR-151856] 21 p0194 N79-12130

**PHASE DIAGRAMS**

The effect of induced disorder on the hydrogenation behaviour of the phase ZrCo 22 p0251 A79-21707

Feasible operating regions for moving bed coal gasification reactors 22 p0297 A79-28983

**PHASE MODULATION**

Closed Loop solar array-ion thruster system with power control circuitry [NASA-CASE-LEW-12780-1] 22 p0357 N79-20179

**PHASE TRANSFORMATIONS**

A simulation study of phase change energy store 21 p0120 A79-17318

Investigation of physical and chemical properties of phase change materials for space heating/cooling applications 21 p0120 A79-17319

Phase change thermal storage for a solar total energy system 21 p0120 A79-17321

Performance of flat plate solar collector with fluid undergoing phase change 21 p0129 A79-17397

Properties optimization for phase-change energy storage in air-based solar heating systems 21 p0149 A79-18018

Thermodynamics of pressure plateaus in metal-hydrogen systems 22 p0238 A79-20772

Mixing effects of two different types of hydrides --- phase behaviors and energy storage applications 22 p0251 A79-21714

Analysis of energy storage by phase change with an array of cylindrical tubes 22 p0281 A79-26207

Fundamental data needs for coal conversion technology appendices [TID-28152-APP] 21 p0187 N79-11512

Experimental two-phase liquid-metal magnetohydrodynamic generator program [AD-A059240] 21 p0197 N79-12564

Novel duplex vapor electrochemical method for silicon solar cells [NASA-CR-158039] 21 p0218 N79-14537

Development of a model and computer code to describe solar grade silicon production processes --- phase changes in chemical reactors [NASA-CR-158037] 21 p0219 N79-14555

Development of a phase-change thermal storage system using modified anhydrous sodium hydroxide for solar electric power generation [NASA-CR-159465] 22 p0354 N79-19454

**PHASED ARRAYS**

Microwave phased array design considerations for SPS --- Solar Powered Satellites 21 p0003 A79-10031

Microwave power transmitting phased array antenna research project [NASA-CR-157843] 21 p0202 N79-13263

**PHENOMENOLOGY**

Battery Energy Storage Test (BEST) Facility. Phenomenological cell modeling: A tool for planning and analyzing battery testing at the BEST facility [COO-2857-1] 21 p0184 N79-11490

# SUBJECT INDEX

# PHOTOLYSIS

## PHOSPHATES

Atlas of western surface-mined lands: Coal, uranium, and phosphate  
[PB-287846/0] 22 p0340 N79-17311

## PHOSPHORIC ACID

Heat transfer in phosphoric acid fuel cell stacks 21 p0010 A79-10091  
Advances in lower cost phosphoric acid fuel cells 21 p0010 A79-10092  
Fuel cell electrocatalysis - Where have we failed 21 p0039 A79-11810  
The state-of-the-art of hydrogen-air phosphoric acid electrolyte fuel cells 21 p0039 A79-11815  
Generation of electrical energy from hydrogen and oxygen by means of fuel cells 21 p0059 A79-13662  
Fuel cell on-site integrated energy system parametric analysis of a residential complex 21 p0081 A79-14947

## PHOTOCHEMICAL REACTIONS

Methods for the photochemical utilization of solar energy 21 p0111 A79-16641  
Solar fuels --- photochemical reaction kinetics and energy storage 21 p0149 A79-18009  
Synthetic chloroplasts --- for photosynthetic solar energy conversion 22 p0262 A79-23721  
Nitrogen oxide air pollution. Part 3: Atmospheric chemistry. A bibliography with abstracts [NTIS/PS-78/0973/4] 21 p0199 N79-12593

## PHOTOCONDUCTIVITY

Optimization of electrical and optical characteristics of silicon photocells used for photothermal concentrated solar radiation converters 21 p0053 A79-13288  
Spectral characteristics of photoconverters with nonuniform defect distribution in the base 21 p0053 A79-13289

## PHOTODECOMPOSITION

Role of semiconductor properties in photoelectrolysis 21 p0037 A79-11780

## PHOTOELECTRIC CELLS

Optimization of electrical and optical characteristics of silicon photocells used for photothermal concentrated solar radiation converters 21 p0053 A79-13288  
Spectral characteristics of photoconverters with nonuniform defect distribution in the base 21 p0053 A79-13289  
Activities in the field of solar cells in the Federal Republic of Germany 21 p0056 A79-13636  
Methods for the photochemical utilization of solar energy 21 p0111 A79-16641  
The feasibility of constructing a photoelectric unit utilizing effluent heat 21 p0125 A79-17358  
Model systems in photoelectrochemical energy conversion 21 p0149 A79-18021  
Photoelectric properties of pCdTe-nCdS film heterojunctions 21 p0166 A79-20347  
Calculating the photocurrent and maximum efficiency of film p-CdTe-n-CdS photocells 21 p0166 A79-20354  
Analysis of the characteristics of silicon photoconverters in the 100-400 K temperature range 21 p0167 A79-20361  
Highly efficient quantum conversion at chlorophyll a-lecithin mixed monolayer coated electrodes --- for solar energy conversion 22 p0273 A79-25548  
Study of photoelectric characteristics of photocells made from high-resistivity silicon 22 p0296 A79-28666  
Effect of solar cell parameter variation on array power output [SAND-78-0917C] 21 p0188 N79-11527

## PHOTOELECTRIC EMISSION

An investigation of dark current and photocurrent superposition in photovoltaic devices 22 p0291 A79-27871

## PHOTOELECTRIC MATERIALS

Progress and trends in the development of terrestrial photoelectric conversion 21 p0056 A79-13635  
The photovoltaic effect in CdS/Cu<sub>2</sub>S solar cells 21 p0091 A79-15871  
Trends in silicon solar-photovoltaic cells - An invited talk 21 p0122 A79-17333  
A new fabrication process for single crystal silicon solar cells 21 p0122 A79-17335  
On the role of interface states in MOS solar cells 21 p0122 A79-17337  
Characterisation of amorphous semiconductor materials for solar cell applications 21 p0123 A79-17341  
DC reactively sputtered metal carbide and metal silicide selective absorbing surfaces --- for photothermal solar energy conversion 21 p0126 A79-17377  
Reliability studies on MIS solar cells 21 p0148 A79-17950  
New models of solar cells and prospects for their optimization 21 p0166 A79-20346  
Characteristics of silicon photoconverters with inversion layer 21 p0166 A79-20349  
Photoelectrolysis of water with semiconductors 22 p0259 A79-23343

## PHOTOELECTROCHEMICAL DEVICES

Symposium on Electrode Materials and Processes for Energy Conversion and Storage, Philadelphia, Pa., May 9-12, 1977, Proceedings 21 p0036 A79-11776  
Role of semiconductor properties in photoelectrolysis 21 p0037 A79-11780  
Iron oxide semiconductor electrodes in photoassisted electrolysis of water 21 p0037 A79-11781  
Semiconductor liquid junction solar cells - Efficiency, electrochemical stability, and surface preparation 21 p0037 A79-11783  
n-CdS/n-GaAs photoanode --- electrochemical solar cells 21 p0037 A79-11784  
Polycrystalline CdSe-based photo-electrochemical cells 21 p0037 A79-11785  
Hydrogen production in a solar-hydrogen economy 21 p0037 A79-11796  
The photogalvanovoltaic cell 21 p0066 A79-14264  
Direct photoelectrochemical conversion and storage of solar energy 21 p0126 A79-17370  
Model systems in photoelectrochemical energy conversion 21 p0149 A79-18021  
Charge transfer by surface states in the photoelectrolysis of water using a semiconductor electrode 22 p0254 A79-22320  
Photoelectrolysis of water with semiconductors 22 p0259 A79-23343

## PHOTOGEOLGY

Landsat - Developing techniques and applications in mineral and petroleum exploration 21 p0111 A79-16725

## PHOTOGRAPHIC RECORDING

Landsat - Developing techniques and applications in mineral and petroleum exploration 21 p0111 A79-16725

## PHOTOIONIZATION

Radiatively sustained cesium plasmas for solar electric conversion 21 p0109 A79-16615

## PHOTOLYSIS

Solar hydrogen production at high temperatures 21 p0104 A79-16464  
Solar photolysis of water [NASA-CASE-NPO-14126-1] 21 p0182 N79-11970

# PHOTOGRAPHING

# SUBJECT INDEX

## PHOTOGRAPHING

Current and potential uses of aerospace technology by the U.S. Department of the Interior [AIAA PAPER 78-1716] 21 p0060 A79-13833

**PHOTOHEATERS**  
Facility with sectioned photoreceiver and laser radiator for determining solar radiation concentrator accuracy characteristics 21 p0054 A79-13292  
Calibration standards and field instruments for the precision measurement of insolation 21 p0076 A79-14765

**PHOTOPRODUCTION**  
Photoproduction of hydrogen by marine blue-green algae [PB-287508/6] 22 p0343 A79-17354

**PHOTOSENSITIVITY**  
Sensitivity calculations for the design of solar cells. I - Schottky barrier devices 21 p0125 A79-17360

**PHOTOSYNTHESIS**  
Compartmental model for agricultural conversion of solar energy into fixed biomass 21 p0022 A79-10181  
Biomimetic approach to solar energy conversion - Artificial photosynthesis 21 p0094 A79-15899  
Petroleum plantations --- hydrocarbon fuels from artificial photosynthesis and plants 21 p0095 A79-15910  
Highly efficient quantum conversion at chlorophyll a-lectithin mixed monolayer coated electrodes --- for solar energy conversion 22 p0273 A79-25548  
Biological conversion of solar energy 22 p0312 A79-31146  
Biological solar energy conversion approaches to overcome yield stability and product limitations [PB-284823/2] 21 p0199 A79-12577

**PHOTOVOLTAIC CELLS**  
Evolution of satellite power system /SPS/ concepts 21 p0002 A79-10023  
Construction of a 10GWe solar power satellite 21 p0003 A79-10029  
Perspectives on utility central station photovoltaic applications 21 p0041 A79-11873  
Cu<sub>2</sub>S-CdS thin-film solar cells 21 p0057 A79-13637  
Practical applications of silicon solar cells in appliances and installations 21 p0057 A79-13638  
The photogalvanovoltaic cell 21 p0066 A79-14264  
Overview of novel photovoltaic conversion techniques at high intensity levels 21 p0108 A79-16610  
Methods for the photochemical utilization of solar energy 21 p0111 A79-16641  
Trends in silicon solar-photovoltaic cells - An invited talk 21 p0122 A79-17333  
Simulation and cost of photovoltaic generators 21 p0122 A79-17334  
Role of high performance solar cells in practical photovoltaic systems 21 p0122 A79-17336  
Characterisation of amorphous semiconductor materials for solar cell applications 21 p0123 A79-17341  
Photovoltaic effect in metal-insulator-semiconductor structure 21 p0123 A79-17343  
On the design of CPC photovoltaic solar collectors. --- Compound Parabolic Concentrator 21 p0124 A79-17355  
Transcell, a novel approach for improving static photovoltaic concentration 21 p0124 A79-17356  
Efficiency of conventional silicon solar cells 21 p0125 A79-17362  
The development of photovoltaic conversion systems with sunlight concentration 21 p0148 A79-17995  
Merocyanine organic solar cells 21 p0165 A79-20216

New models of solar cells and prospects for their optimization 21 p0166 A79-20346

Characteristics of silicon photoconverters with inversion layer 21 p0166 A79-20349

Recent developments in low cost silicon solar cells for terrestrial applications --- sheet production methods 22 p0239 A79-20821

Integral assembly of photovoltaic arrays using glass 22 p0241 A79-20883

Temperature dependence of photovoltaic solar energy conversion for GaAs homojunction solar cell 22 p0256 A79-22768

Performance of a new high-intensity silicon solar cell 22 p0257 A79-22862

An investigation of dark current and photocurrent superposition in photovoltaic devices 22 p0291 A79-27871

Ga<sub>1-x</sub>Al<sub>x</sub>/As-GaAs photovoltaic cells with multilayer structure --- heterostructure solar cell fabrication 22 p0305 A79-30258

The limiting efficiency of an edge-illuminated multigap solar cell 22 p0305 A79-30259

Do photovoltaics have a future [ASME PAPER 79-SOL-7] 22 p0308 A79-30543

Field tests of photovoltaic power systems [ASME PAPER 79-SOL-10] 22 p0308 A79-30545

Structural cost optimization of photovoltaic central power station modules and support structure [ASME PAPER 79-SOL-17] 22 p0309 A79-30551

Solar array systems 21 p0169 A79-10131

Status of the DOE photovoltaic concentrator technology development project [SAND-78-0948C] 21 p0176 A79-10550

Solar cells having integral collector grids [NASA-CASE-LEW-12819-1] 21 p0182 A79-11467

High performance GaAs photovoltaic cells for concentrator applications [SAND-78-7018] 21 p0187 A79-11521

Development of high-efficiency P(+)-N-N(+) back-surface-field silicon solar cells [SAND-78-1156C] 21 p0188 A79-11529

National photovoltaic program plan [DOE/ET-0035(78)] 21 p0197 A79-12567

Silicon Schottky photovoltaic diodes for solar energy conversion [PB-283998/3] 21 p0198 A79-12572

Industrialization study --- impact of government incentives and barriers on decision making in the industrial production of photovoltaics [NASA-CR-157953] 21 p0200 A79-12970

Design of low-cost structures for photovoltaic arrays. Task 1: Survey of array structural characteristics [SAND-78-7021] 21 p0206 A79-13509

Silicon solar cells, volume 2. Citations from the NTIS data base [NTIS/PS-78/1114/4] 21 p0212 A79-13554

Silicon solar cells, volume 2. Citations from the NTIS data base [NTIS/PS-78/1116/9] 21 p0212 A79-13556

Solar electric power generation, volume 2. Citations from the NTIS data base [NTIS/PS-78/1108/6] 21 p0212 A79-13557

Improved semiconductors for photovoltaic solar cells [DSE/2459-2] 21 p0221 A79-14577

Industrialization study, phase 2 --- assessment of advanced photovoltaic technologies for commercial development [NASA-CR-158015] 22 p0333 A79-16351

Photovoltaic tests and applications project [NASA-TN-79018] 22 p0342 A79-17336

Silicon Schottky photovoltaic diodes for solar energy conversion [PB-287417/0] 22 p0343 A79-17349

Measurement techniques for solar cells [PB-287519/3] 22 p0343 A79-17352

V-groove multijunction solar cells 22 p0353 A79-19445

Market definition studies for photovoltaic highway applications [NASA-CR-159477] 22 p0354 A79-19451



# SUBJECT INDEX

# PHYSICAL PROPERTIES

Thermal and other tests of photovoltaic modules performed in natural sunlight [NASA-CR-158174] 22 p0354 N79-19460

Feasibility study of solar dome encapsulation of photovoltaic arrays [NASA-CR-158368] 22 p0367 N79-21545

**PHOTOVOLTAIC CONVERSION**

Ultralow-mass solar-array designs for Halley's comet rendezvous mission 21 p0020 A79-10169

The application of photovoltaic roof shingles to residential and commercial buildings 21 p0020 A79-10170

Cost minimization of photovoltaic power supplies 21 p0021 A79-10171

Photovoltaic concentrating array 21 p0021 A79-10172

Optics applied to solar energy conversion; Proceedings of the Seminar, San Diego, Calif., August 23, 24, 1977 21 p0042 A79-11965

Analysis of a direct coupling d.c. motor and a photovoltaic converter 21 p0046 A79-12272

Progress and trends in the development of terrestrial photoelectric conversion 21 p0056 A79-13635

Photovoltaic overview [AIAA PAPER 78-1763] 21 p0061 A79-13864

Venture analysis of a proposed federal photovoltaic eight-year procurement plan [AIAA PAPER 78-1766] 21 p0061 A79-13865

Pennies a day - Financing early deployment of photovoltaic utility applications through a user subsidy [AIAA PAPER 78-1767] 21 p0061 A79-13866

NASA Lewis Research Center photovoltaic application experiments [AIAA PAPER 78-1768] 21 p0061 A79-13867

Solar total energy systems 21 p0090 A79-15863

Solar power satellites revisited 21 p0093 A79-15898

Status of photovoltaic systems and applications 21 p0095 A79-15907

Overview of novel photovoltaic conversion techniques at high intensity levels 21 p0108 A79-16610

Amorphous semiconductors in photovoltaic and solar thermal conversion 21 p0122 A79-17339

Large area silicon sheet by EFG --- Edge-defined Film-fed Growth 21 p0123 A79-17340

Investigation on junction formation and realization of high open-circuit voltage in Cu<sub>x</sub>/S-CdS solar cells 21 p0123 A79-17344

Improvement of efficiency and stability by copper-treatment and front contacting of Cu<sub>x</sub>/S-CdS solar cells 21 p0123 A79-17345

The photovoltaic effects in CdS/Cu<sub>2</sub>S solar cells 21 p0123 A79-17347

Concentrator photovoltaic systems for economical electricity and heat 21 p0124 A79-17354

Sensitivity calculations for the design of solar cells. I - Schottky barrier devices 21 p0125 A79-17360

A cost effective total energy system using a faceted mirror sunlight concentrator and high intensity solar cells 21 p0135 A79-17446

Solar retrofitting of existing residence with almost zero delta TE system 21 p0139 A79-17485

25 kilowatt photovoltaic powered irrigation and grain drying experiment 21 p0143 A79-17519

The development of photovoltaic conversion systems with sunlight concentration 21 p0148 A79-17995

A high-efficiency GaAs double-heterostructure photovoltaic detector --- with antireflection coating 21 p0154 A79-18489

Photoacoustic determination of photovoltaic energy conversion efficiency 21 p0154 A79-18503

Explanation for low-efficiency Cu<sub>2</sub>O Schottky-barrier solar cells 22 p0256 A79-22859

Encapsulant materials for \$2/watt terrestrial photovoltaic arrays 22 p0266 A79-24138

Photovoltaic power systems for rural areas of developing countries 22 p0278 A79-26131

Radiation energy conversion in space 22 p0284 A79-26595

A proposed thermophotovoltaic solar energy conversion system 22 p0287 A79-27317

Solar power satellite 22 p0287 A79-27375

A flywheel energy storage and conversion system for solar photovoltaic applications [ASME PAPER 79-SOL-1] 22 p0307 A79-30539

Photovoltaic concentrator system technology and applications experiments [ASME PAPER 79-SOL-9] 22 p0308 A79-30544

Solar photovoltaic power for residential use [ASME PAPER 79-SOL-11] 22 p0308 A79-30546

An overview of photovoltaic power systems [ASME PAPER 79-SOL-12] 22 p0308 A79-30547

Unique aspects of terrestrial photovoltaic system design [ASME PAPER 79-SOL-14] 22 p0308 A79-30548

Photovoltaic electric power generation from a utility perspective [ASME PAPER 79-SOL-18] 22 p0309 A79-30552

Photovoltaic properties of metal-free phthalocyanines - Al/H<sub>2</sub>Pc Schottky barrier solar cells 22 p0317 A79-31412

Photovoltaics and solar thermal conversion to electricity - Status and prospects 22 p0326 A79-31924

Applied research on energy storage and conversion for photovoltaic and wind energy systems. Volume 3: Wind conversion systems with energy storage [HCP/T22221-01/3] 21 p0189 N79-11535

Environmental Development Plan (EDP): Photovoltaics, 1977 [DOE/EDP-0003] 21 p0198 N79-12569

Combined photovoltaic thermal collector testing [SAND-78-1191C] 21 p0198 N79-12570

Applied research on energy storage and conversion for photovoltaic and wind energy systems. Volume 2: Photovoltaic systems with energy storage [HCP/T22221-01/2-2] 21 p0207 N79-13510

Applied research on energy storage and conversion for photovoltaic and wind energy systems. Volume 1: Study summary and concept screening [HCP/T22221-01/1-VOL-1] 21 p0207 N79-13511

Photovoltaic program: Program summary [DOE/ET-0019/1] 21 p0209 N79-13529

Satellite Power Systems (SPS) concept definition study. Volume 3: SPS concept evolution [NASA-CR-158066] 21 p0225 N79-15138

Photovoltaic power systems for rural areas of developing countries [NASA-TN-79097] 21 p0229 N79-15411

**PHOTOVOLTAIC EFFECT**

Photovoltaic effects in II-VI heterojunctions 21 p0042 A79-11967

The photovoltaic effect in CdS/Cu<sub>2</sub>S solar cells 21 p0091 A79-15871

**PHthalocyanine**

Photovoltaic properties of metal-free phthalocyanines - Al/H<sub>2</sub>Pc Schottky barrier solar cells 22 p0317 A79-31412

**PHYSICAL PROPERTIES**

Investigation of physical and chemical properties of phase change materials for space heating/cooling applications 21 p0120 A79-17319

Evaluated physical properties data for materials used in energy storage systems [UCRL-81159] 21 p0189 N79-11536

# PILOT PERFORMANCE

# SUBJECT INDEX

## PILOT PERFORMANCE

Pilot's view of the evolving air transport  
21 p0053 A79-13085

## PILOT PLANTS

Operation of the Ft. Lewis, Washington Solvent  
Refined Coal /SRC/ Pilot Plant in the SRC I and  
SRC II processing modes  
21 p0006 A79-10054

Synthane - A process for the gasification of  
caking and noncaking coals  
21 p0006 A79-10057

Gasification of coal liquefaction residues  
21 p0006 A79-10059

Low-Btu gas from the IGI ash-agglomeration  
gasification process  
21 p0009 A79-10077

A proposed 40 MWe MHD pilot plant  
21 p0017 A79-10137

Central solar heat stations and the Studsvik  
Demonstration Plant  
21 p0021 A79-10175

Predicted performance of heliostats for ERDA's 10  
MWe power plant  
21 p0044 A79-12045

Coal desulfurization test plant status - July 1977  
--- utilizing Meyers leach process  
21 p0044 A79-12118

Solar One - A 10-megawatt solar thermal central  
receiver pilot plant project  
[AIAA PAPER 78-1750]  
21 p0060 A79-13853

Dynamic computer simulation of the DOE 10 MW solar  
thermal pilot plant  
[AIAA PAPER 78-1752]  
21 p0060 A79-13854

Steam raising with low-Btu gas generators and  
potential for other applications  
21 p0072 A79-14690

Design study of a thermohydraulic loop for the  
conversion of geothermal energy /low enthalpy/  
into electricity  
21 p0076 A79-14741

H-Coal pilot plant project and status of  
commercial development at Ashland --- coal  
gasification producing hydrogen and hydrocarbons  
21 p0092 A79-15888

Development of central station power plants  
integrated with coal gasifiers --- utilizing  
molten-carbonate fuel cells  
21 p0093 A79-15895

SNG production by the Rockgas process  
21 p0093 A79-15896

10-megawatt solar central receiver pilot plant  
21 p0094 A79-15906

A status report on the Solar Thermal Test Facility  
21 p0112 A79-16731

The Koppelman process --- to upgrade lignite and  
some waste energy sources  
21 p0145 A79-17634

The H-Coal project --- catalytic hydrogenation of  
coal  
21 p0145 A79-17635

Failure analysis in coal conversion systems ---  
pilot plant for liquefaction  
22 p0266 A79-24137

Performance of a 5 MWe solar steam generator  
22 p0288 A79-27399

Solar pilot plant, phase 1  
[SAN/1109-77-7]  
21 p0210 A79-13542

Requirements for environmental monitoring  
assessment, and controls for nonnuclear energy  
demonstration projects. Report to Congress,  
prepared in fulfillment of Public Law 95-39,  
section 113  
[DOE/EV-0014]  
21 p0213 A79-13573

Recommendations for the conceptual design of the  
Barstow, California, solar central receiver  
pilot plant: Executive summary  
[SAND-77-8035]  
21 p0221 A79-14571

Engineering test facility conceptual design, part 1  
[FE-2614-2-PT-1]  
22 p0369 A79-21560

Engineering test facility conceptual design, part 2  
[FE-2614-2-PT-2]  
22 p0369 A79-21561

## PIPE FLOW

Effect of buoyancy and tube inclination on heat  
transfer in a solar air heater  
21 p0129 A79-17402

Heat exchangers for Ocean Thermal Energy  
Conversion plants  
21 p0142 A79-17506

## PIPELINES

Problems, status, and prospects of a solar  
hydrogen economy  
21 p0059 A79-13658

Environmentally induced cracking of natural gas  
and liquid pipelines. Volume 2: Appendices A  
and B  
[PB-282924/0]  
21 p0181 A79-11446

Environmentally induced cracking of natural gas  
and liquid pipelines. Volume 1: Technical report  
[PB-282923/2]  
21 p0181 A79-11447

## PIPES (TUBES)

Optimum collection geometries for copper tube -  
copper sheet flat plate collectors  
21 p0127 A79-17387

The use of heat exchangers with THERMOEXCEL's  
tubing in ocean thermal energy power plants  
[ASME PAPER 78-WA/HT-65]  
21 p0162 A79-19825

Analysis and experimental tests of a  
high-performance evacuated tubular collector  
[NASA-CR-150874]  
22 p0334 A79-16370

## PISTON ENGINES

Balanced compounding of Stirling machines  
21 p0024 A79-10200

Influence of cyclic wall-to-gas heat transfer in  
the cylinder of the valved hot-gas engine  
21 p0024 A79-10201

Conversion of a standard single cylinder I.C.  
engine into a 'gamma' configuration air charged  
Stirling engine  
21 p0024 A79-10202

Design of a preprototype Stirling Laboratory  
Research Engine  
21 p0024 A79-10203

The matching of a free piston Stirling engine  
coupled with a free piston linear compressor for  
a heat pump application  
21 p0024 A79-10204

A free-piston Stirling engine for small solar  
power plants  
21 p0024 A79-10205

Conceptual design of a variable displacement  
Stirling engine for automotive propulsion  
21 p0025 A79-10207

Radioisotope-powered free-piston Stirling engine  
for space applications  
[IAF PAPER 78-42]  
21 p0034 A79-11217

Energy conservation in general aviation and  
operation and maintenance of Avco Lycoming  
piston engines  
21 p0048 A79-12381

Alternative fuels for reciprocating internal  
combustion engines  
21 p0051 A79-12980

The Stirling engine, an energy converter for  
cogeneration applications  
[ASME PAPER 78-WA/ENER-4]  
21 p0159 A79-19777

Dynamic characteristics of a free-piston diesel  
engine combined with a MHD generator  
22 p0258 A79-23137

A one-dimensional combustion model for a dual  
chamber stratified charge spark ignition engine  
[SAE PAPER 790355]  
22 p0315 A79-31371

Tests of Wisconsin S12D engine running on natural  
gas with addition of carbon dioxide  
[AD-A058486]  
22 p0339 A79-17230

## PISTON THEORY

Electromagnetic excitation of a moving conducting  
piston  
22 p0237 A79-20658

Electromechanical conversion of energy during the  
deceleration of a piston in a uniform magnetic  
field  
22 p0309 A79-30599

## PISTONS

Review of liquid piston pumps and their operation  
with solar energy  
[ASME PAPER 79-SOL-4]  
22 p0308 A79-30542

## PITCH (INCLINATION)

Optimum tube pitch in solar collectors  
21 p0132 A79-17421

Optimising the pitching of tubes in a flat solar  
collector for increasing the efficiency for use  
in vapour absorption refrigeration  
21 p0132 A79-17422

# SUBJECT INDEX

# PLASMA CONTROL

## PLANAR STRUCTURES

Augmented solar energy collection using various planar reflective surfaces: Theoretical calculations and experimental results [LA-7041] 21 p0185 N79-11494

## PLANETARY ENVIRONMENTS

Optimization and design of radiative heat-discharge system for energy unit with Stirling engine --- operating in planetary environment 21 p0166 A79-20348

## PLANTS (BOTANY)

Biomass utilization in Minnesota [PB-282531/3] 21 p0171 N79-10241  
Biological solar energy conversion: Approaches to overcome yield, stability and product limitations [PB-286487/4] 21 p0230 N79-15422

## PLASMA COMPOSITION

Cyclotron-wave spectrum in a plasma with two ion species 22 p0245 A79-21443  
Performance of a closed-cycle MHD generator with molecular impurities 22 p0283 A79-26524  
On the motion of runaway electrons in momentum space --- analysis for multi-component plasma in tokamaks 22 p0291 A79-27880  
The effects of wall temperature on light impurities in Alcator --- tokamak device 22 p0313 A79-31188  
Calculation of the Q factor for a two-component tokamak 22 p0324 A79-31763

## PLASMA CONDUCTIVITY

Radiatively sustained cesium plasmas for solar electric conversion 21 p0109 A79-16615  
The electric conductivity of a plasma of combustion products of hydrocarbon fuels with alkali impurity 21 p0167 A79-20415  
Experimental studies of a linear MHD generator with fully ionized seed 22 p0238 A79-20796

## PLASMA CONTROL

Doublet III design and construction --- Tokamak fusion research device 21 p0018 A79-10145  
Demonstration and commercial prototype tokamak reactors 21 p0018 A79-10146  
The Mirror Fusion Test Facility /MFTF/ 21 p0018 A79-10147  
Mirror fusion reactors 21 p0018 A79-10148  
Overview of inertial confinement fusion reactor designs 21 p0018 A79-10149  
A calculation of linear magnetic liner fusion reactor performance 21 p0018 A79-10153  
Heavy-ion beam inertial-confinement fusion 21 p0054 A79-13448  
Recent results from the PLT tokamak 21 p0069 A79-14453  
Review of tokamak theory results 21 p0069 A79-14454  
Progress in tokamak experimental research in the Soviet Union 21 p0069 A79-14455  
Review of results from DITE tokamak 21 p0069 A79-14456  
Experiments on adiabatic compression of a tokamak plasma in Tuman-2 21 p0069 A79-14457  
Ohmic heating experiments in the W VII A stellarator 21 p0069 A79-14458  
Heating and confinement in the CLEO stellarator 21 p0070 A79-14459  
Ohmic heating experiments in the L-2 stellarator 21 p0070 A79-14460  
The mirror machine program in the USA --- controlled fusion experiments and research facilities 21 p0070 A79-14461  
Toroidal high-beta systems 21 p0070 A79-14462

New results in high-beta stellarator and belt-pinch research 21 p0070 A79-14463

Fusion reactor problems --- plasma confinement and interface engineering 21 p0071 A79-14468

Tokamak reactors for breakeven: A critical study of the near-term fusion reactor program --- Book 21 p0077 A79-14776

Review of experimental results. I, II --- MHD instability effects on tokamak confinement with ohmic heating 21 p0077 A79-14778

MHD equilibrium and stability --- in tokamak devices 21 p0078 A79-14779

Magnetic divertors --- in large tokamak plasma confinement experiments 21 p0078 A79-14781

The 'PINTOR 1' design - A minimum size tokamak experimental reactor 21 p0078 A79-14782

Philosophy and physics of predemonstration fusion devices 21 p0078 A79-14783

Characteristics of a predemonstration fusion device 21 p0078 A79-14784

Predemonstration fusion devices - Research and development needs 21 p0078 A79-14785

Compact experiments for alpha-particle heating --- of confined D-T plasma in tokamak 21 p0078 A79-14786

Superconducting magnets - Some fundamentals and their state of the art 21 p0079 A79-14788

The impact of servicing requirements on tokamak fusion reactor design 21 p0079 A79-14793

Fusion power by magnetic confinement - Program plan 21 p0080 A79-14794

Dynamics and feedback control of ISX tokamak 21 p0107 A79-16559

Magnetically confined plasma solar collector --- satellite based system in space 21 p0109 A79-16617

Plywheel energy storage system for JT-60 toroidal field coil 21 p0112 A79-16729

Radially resolved measurements of 'q' on the adiabatic toroidal compressor tokamak --- safety factor 21 p0155 A79-18830

Effect of the magnetic configuration of the poloidal diverter on the plasma in the T-12 finger-ring tokamak 22 p0244 A79-21429

Optimum properties of a noncylindrical pinch --- neutron energy yield in fusion plasma 22 p0244 A79-21433

Minimum-average-B wells in linked magnetic mirror fields --- for plasma control in fusion reactors 22 p0252 A79-22237

Particle orbits in field-reversed mirrors --- for plasma confinement in fusion reactor 22 p0253 A79-22239

Empirical scaling laws for energy confinement in ohmically-heated tokamaks 22 p0253 A79-22240

An overview of design space for small fusion targets 22 p0253 A79-22241

Space-dependent thermal stability of reacting tokamak plasmas 22 p0253 A79-22242

Local theory of finite-beta, collisional drift modes --- plasma stability analysis 22 p0253 A79-22244

Fuel content characterization and pressure retention measurements of DT-filled laser fusion microballoon targets 22 p0258 A79-23034

Asymptotic theory of dissipative trapped electron mode overlapping many rational surfaces --- in toroidal plasmas 22 p0270 A79-24855

Theory of anomalous transport due to electrostatic fluctuations --- low frequency plasma instabilities of drift wave type 22 p0270 A79-24858

MHD stability for a spherator with a purely poloidal magnetic field 22 p0271 A79-24863

Macroscopic stability and beta limit in the ELMO Bumpy Torus 22 p0291 A79-27876

The effect of limiters and current profile on elliptic free-boundary MHD equilibria 22 p0291 A79-27881

Stabilization of drift loss-cone instability /DCI/ by addition of cold ions --- in collisional hydrogen plasma confinement 22 p0291 A79-27882

Theory of dissipative drift instabilities in sheared magnetic fields --- in confined toroidal plasmas 22 p0292 A79-27884

Evidence for neutral-beam-injected oxygen impurities in 2XIB --- mirror confined plasma 22 p0292 A79-27887

Theory of the striated corona in a theta pinch 22 p0295 A79-28315

Cryogenic technology and superconductivity in controlled fusion 22 p0311 A79-31003

Design and development of the US-TESPE toroidal coil 22 p0311 A79-31014

Radial transport in the ELMO Bumpy Torus in collisional regimes 22 p0312 A79-31184

MHD stability of Spheromak 22 p0313 A79-31189

Plasma behavior near the neutral line between parallel currents --- in planar zeta pinch 22 p0324 A79-31754

Experiments on controlling the plasma density in the TO-1 tokamak 22 p0324 A79-31762

A scheme for direct conversion of plasma thermal energy into electrical energy 22 p0324 A79-31765

The formulation of the wall stabilization problem of an axisymmetrical toroidal sharp-boundary plasma with a horizontally elongated noncircular cross section 22 p0327 A79-32103

Overview of the magnetic fusion energy development and technology program [HCP/T3073-01] 21 p0193 A79-11887

**PLASMA CORE REACTORS**

Gaseous fuel reactors for power systems [LA-UR-78-1437] 21 p0214 A79-13844

**PLASMA CYLINDERS**

A calculation of linear magnetic liner fusion reactor performance 21 p0018 A79-10153

Experiments on adiabatic compression of a tokamak plasma in Tuman-2 21 p0069 A79-14457

Electron cyclotron heating in high density toroidal plasmas 22 p0265 A79-24037

Self-consistent analysis of alpha-particle heating of a fast-solenoid plasma --- in laser fusion 22 p0291 A79-27879

Dynamic stabilization of toroidal discharges in weak longitudinal magnetic fields 22 p0324 A79-31766

**PLASMA DENSITY**

Measurements of compressed core density of laser-imploded targets by x-ray continuum-edge shift 21 p0154 A79-18479

Stimulated Raman scatter in laser fusion target chambers 21 p0155 A79-18794

Plasma density measurements on refuelling by solid hydrogen pellets in a rotating plasma 22 p0255 A79-22369

A simple neutral density profile calculation for tokamaks with lambda sub mfp much smaller than a 22 p0255 A79-22379

The effect of thermo-electric forces on the density profiles in a thermonuclear plasma surrounded by a cold blanket 22 p0292 A79-27886

Experiments on controlling the plasma density in the TO-1 tokamak 22 p0324 A79-31762

**PLASMA DIAGNOSTICS**

Plasma diagnostics in an MHD installation 21 p0106 A79-16492

Laser measurements of the radial profiles of the electron temperature and density in the FT-1 tokamak 22 p0244 A79-21430

Structure of the current shell in a Z pinch 22 p0245 A79-21434

Investigation of a staged plasma-focus apparatus --- pinch construction and current sheet dynamics investigation 22 p0255 A79-22365

Plasma density measurements on refuelling by solid hydrogen pellets in a rotating plasma 22 p0255 A79-22369

Diagnostics of Shiva Nova high-yield thermonuclear events --- in laser fusion 22 p0285 A79-26747

**PLASMA DIFFUSION**

On the ion energy balance in TFR with and without neutral injection heating 21 p0069 A79-14452

Collisional transport --- particle diffusion and heat transport in tokamak 21 p0078 A79-14780

Equilibrium relations in the presence of arbitrary plasma diffusion in axisymmetric configurations 22 p0257 A79-22979

Collisional transport --- of plasmas in plane and toroidal geometry 22 p0257 A79-22980

Quasi-linear theory of heat flow and diffusion in a tokamak 22 p0270 A79-24859

On the diffusive instability of some simple steady magnetohydrodynamic flows 22 p0278 A79-26163

**PLASMA DIODES**

Contribution to the theory of the pulsed mode of operation of the thermionic energy converter. II 22 p0246 A79-21542

**PLASMA DYNAMICS**

Transport phenomena in MHD generators - Effect of boundary layers 21 p0156 A79-19098

**PLASMA ELECTRODES**

Effects of position of output electrodes in entrance region of open-cycle diagonal type MHD generator 21 p0153 A79-18468

Effect of electrode shielding on beamlet-beamlet interaction in multiaperture sources 21 p0154 A79-18481

Construction of a mathematical model for MHD generator electrodes in the arc regime of operation 22 p0258 A79-23138

Three-dimensional effects of electrode configuration on diagonal MHD generator performance 22 p0283 A79-26523

**PLASMA EQUILIBRIUM**

Equilibrium relations in the presence of arbitrary plasma diffusion in axisymmetric configurations 22 p0257 A79-22979

MHD instabilities 22 p0259 A79-23599

MHD stability for a spherator with a purely poloidal magnetic field 22 p0271 A79-24863

Macroscopic stability and beta limit in the ELMO Bumpy Torus 22 p0291 A79-27876

The effect of limiters and current profile on elliptic free-boundary MHD equilibria 22 p0291 A79-27881

The formulation of the wall stabilization problem of an axisymmetrical toroidal sharp-boundary plasma with a horizontally elongated noncircular cross section 22 p0327 A79-32103

**PLASMA FOCUS**

Development of energetic neutral beams to the megawatt power level for controlled thermonuclear research 21 p0054 A79-13439

# SUBJECT INDEX

# PLASMA TURBULENCE

- Generation and applications of high power ion beams to fusion research  
21 p0070 A79-14466
- Investigation of a staged plasma-focus apparatus --- pinch construction and current sheet dynamics investigation  
22 p0255 A79-22365
- Microstability of a focused ion beam propagating through a z-pinch plasma  
22 p0270 A79-24817
- PLASMA FREQUENCIES**  
Non-thermal emission at the plasma frequency --- spectra obtained on tokamak fusion reactors  
22 p0270 A79-24854
- PLASMA GENERATORS**  
Radiatively sustained cesium plasmas for solar electric conversion  
21 p0109 A79-16615
- The TELEC - A plasma type of direct energy converter --- Thermo-Electronic Laser Energy Converter for electric power generation  
21 p0110 A79-16629
- Magnetic multipole line-cusp plasma generator for neutral beam injectors  
22 p0238 A79-20746
- PLASMA HEATING**  
Compact fusion reactors using controlled imploding liners  
21 p0018 A79-10151
- The fast power cycle for fusion reactors  
21 p0018 A79-10152
- On the ion energy balance in TFR with and without neutral injection heating  
21 p0069 A79-14452
- Recent results from the PLT tokamak  
21 p0069 A79-14453
- Progress in tokamak experimental research in the Soviet Union  
21 p0069 A79-14455
- Experiments on adiabatic compression of a tokamak plasma in Tuman-2  
21 p0069 A79-14457
- Ohmic heating experiments in the W VII A stellarator  
21 p0069 A79-14458
- Heating and confinement in the CLEO stellarator  
21 p0070 A79-14459
- Ohmic heating experiments in the L-2 stellarator  
21 p0070 A79-14460
- Present status of two R.F. heating schemes - I.C.R.H. and L.H.R.H. --- Ion Cyclotron Resonant Heating and Lower-Hybrid Resonant Heating of plasma  
21 p0071 A79-14467
- Review of experimental results. I, II --- MHD instability effects on tokamak confinement with ohmic heating  
21 p0077 A79-14778
- Compact experiments for alpha-particle heating --- of confined D-T plasma in tokamak  
21 p0078 A79-14786
- Auxiliary heating in breakeven tokamaks  
21 p0079 A79-14792
- The advanced thermionic converter with microwave power as an auxiliary ionization source  
21 p0153 A79-18470
- Conceptual design of a superconducting tokamak - 'TORUS II SUPRA'  
22 p0236 A79-20543
- Properties of the plasma ions and the particle lifetime in ohmic heating in the L-2 stellarator  
22 p0244 A79-21428
- Fast penetration of a magnetic field into a low-density plasma  
22 p0244 A79-21432
- The synergetics of the catalytic D-D-fusion-fission breeder  
22 p0252 A79-22236
- Empirical scaling laws for energy confinement in ohmically-heated tokamaks  
22 p0253 A79-22240
- Electron cyclotron heating in high density toroidal plasmas  
22 p0265 A79-24037
- RF-heating in stationary systems --- of toroidal plasma in tokamaks  
22 p0271 A79-24864
- Lower hybrid resonance heating --- of tokamak plasma  
22 p0271 A79-24865
- Magneto-acoustic resonance heating in the ion-cyclotron frequency domain --- of tokamak plasmas  
22 p0271 A79-24866
- Wave propagation and absorption near the electron-cyclotron layer in the 'THOR' device --- microwave heating of tokamak plasma  
22 p0271 A79-24867
- Self-consistent analysis of alpha-particle heating of a fast-solenoid plasma --- in laser fusion  
22 p0291 A79-27879
- Characteristics of electron-cyclotron-resonance-heated tokamak power reactors  
22 p0292 A79-27885
- 200-kv Blumlein transmission line for ultrafast toroidal theta-pinch  
22 p0297 A79-28917
- A ray-tracing analysis of fast-wave heating of tokamaks  
22 p0313 A79-31186
- MHD gas turbine energy conversion for mirror fusion reactors  
22 p0313 A79-31192
- PLASMA INTERACTIONS**  
Slag deposition and its effect on the performance of MHD channels --- in electric generators [AIAA PAPER 79-0189]  
21 p0157 A79-19588
- PLASMA JETS**  
Investigation of the Hall effect in a discharge with a rotational electric field  
22 p0246 A79-21532
- PLASMA LIFETIME**  
Properties of the plasma ions and the particle lifetime in ohmic heating in the L-2 stellarator  
22 p0244 A79-21428
- PLASMA OSCILLATIONS**  
Experiments on adiabatic compression of a tokamak plasma in Tuman-2  
21 p0069 A79-14457
- PLASMA PHYSICS**  
Philosophy and physics of predemonstration fusion devices  
21 p0078 A79-14783
- PLASMA PINCH**  
Toroidal high-beta systems  
21 p0070 A79-14462
- New results in high-beta stellarator and belt-pinch research  
21 p0070 A79-14463
- Characterization of electron and ion current flow in very large aspect-ratio terawatt diodes employing heated and unheated anodes  
21 p0154 A79-18480
- Optimum properties of a noncylindrical pinch --- neutron energy yield in fusion plasma  
22 p0244 A79-21433
- Structure of the current shell in a Z pinch  
22 p0245 A79-21434
- Investigation of a staged plasma-focus apparatus --- pinch construction and current sheet dynamics investigation  
22 p0255 A79-22365
- PLASMA POTENTIALS**  
Optimization of a Knudsen Cs-Ba thermionic converter  
22 p0241 A79-20940
- PLASMA RESONANCE**  
Lower hybrid resonance heating --- of tokamak plasma  
22 p0271 A79-24865
- PLASMA SPECTRA**  
Measurements of plasma rotation in tokamak L-3  
22 p0252 A79-22238
- The contribution of plasma dielectric properties to the cyclotron radiation spectrum from a tokamak plasma  
22 p0312 A79-31183
- Interpretation of cyclotron radiation spectra from runaway discharges in TFR  
22 p0313 A79-31185
- PLASMA TEMPERATURE**  
Transport phenomena in MHD generators - Effect of boundary layers  
21 p0156 A79-19098
- PLASMA TURBULENCE**  
Fast penetration of a magnetic field into a low-density plasma  
22 p0244 A79-21432

## PLASMA WAVES

## SUBJECT INDEX

- Turbulence of a combustion product plasma in an  
MHD channel 22 p0246 A79-21538
- PLASMA WAVES**  
Cyclotron-wave spectrum in a plasma with two ion  
species 22 p0245 A79-21443  
Single-particle behaviour in plasmas 22 p0257 A79-22977  
Parametric decay of lower hybrid waves in a plasma  
- Effect of ion nonlinearity --- in tokamaks 22 p0269 A79-24814  
Effects of nonlinear decay of backscattered light  
on the anomalous reflectivity --- in laser plasmas 22 p0310 A79-30742
- PLASMA-ELECTROMAGNETIC INTERACTION**  
On the flow of a conducting fluid between parallel  
disks with a transverse magnetic field. I - A  
theoretical investigation on a nonequilibrium  
plasma flow as a compressible inviscid fluid 21 p0156 A79-19445  
Fast penetration of a magnetic field into a  
low-density plasma 22 p0244 A79-21432  
Single-particle behaviour in plasmas 22 p0257 A79-22977  
Electrical power loss from high-voltage power  
circuits through plasma leakage 21 p0169 A79-10113
- PLASMA-PARTICLE INTERACTIONS**  
Generation and applications of high power ion  
beams to fusion research 21 p0070 A79-14466  
Single-particle behaviour in plasmas 22 p0257 A79-22977  
Heat transport near the wall of a tokamak reactor 22 p0324 A79-31764
- PLASTIC FLOW**  
Continuous extrusion of coal --- plastic  
fluidizing process 22 p0282 A79-26372
- PLASTICS**  
Use of plastics in solar energy applications 21 p0067 A79-14268  
Thermal power systems point-focusing distributed  
receiver technology project. Volume 1:  
Executive summary [NASA-CR-158421] 22 p0360 A79-20492
- PLATING**  
New processes for black coatings useful in  
harnessing solar energy. I - A room temperature  
black chromium plating bath 21 p0127 A79-17379
- PLUMES**  
The impact of a coal fired power plant on ambient  
sulfur dioxide levels 21 p0082 A79-15032
- PLUTONIUM OXIDES**  
Environmental and radiological safety studies.  
Interaction of (Pu-238)O<sub>2</sub> heat sources with  
terrestrial and aquatic environments --- soil  
and water analysis [LA-7033-PR] 21 p0232 A79-15783
- PLUTONIUM 238**  
Mini-Brayton heat source assembly development  
[NASA-CR-159447] 21 p0196 A79-12554  
Proliferation-resistant nuclear fuel cycles  
[ORNL/TM-6392] 21 p0214 A79-13849  
Environmental and radiological safety studies.  
Interaction of (Pu-238)O<sub>2</sub> heat sources with  
terrestrial and aquatic environments --- soil  
and water analysis [LA-7033-PR] 21 p0232 A79-15783
- PNEUMATIC EQUIPMENT**  
Experiences with a hydropneumatic wave power device 21 p0151 A79-18105
- POINTING CONTROL SYSTEMS**  
Effects of pointing errors on receiver performance  
for parabolic dish solar concentrators 21 p0020 A79-10167  
Attitude and pointing control system for the  
microwave antenna of the solar power satellite 21 p0113 A79-16739  
A simple solar tracking system --- manually  
adjusted rotating shaft for solar concentrator  
positioning 21 p0136 A79-17457  
Computer based sun following system 22 p0242 A79-21165
- Accuracy analysis of pointing control system of  
solar power station [NASA-CR-150880] 21 p0215 A79-14143
- POLAR REGIONS**  
Energy conversion at a lunar polar site 21 p0108 A79-16607
- POLARIZATION (CHARGE SEPARATION)**  
Migrational polarization in high-current density  
molten salt electrochemical devices 21 p0039 A79-11811
- POLICIES**  
Public policy 21 p0179 A79-11011  
United States civilian space programs: An overview  
[GPO-35-823] 21 p0232 A79-15815
- POLLUTION CONTROL**  
Factors limiting limestone utilization efficiency  
in fluidized-bed combustors --- in determining  
sulfur dioxide emission level 21 p0008 A79-10069  
Circulating-bed boiler concepts for steam and  
power generation 21 p0008 A79-10071  
Pressurized fluidized-bed combustion/component  
test and integration unit preliminary design  
report 21 p0008 A79-10076  
Low-Btu gas from the IGT ash-agglomeration  
gasification process 21 p0009 A79-10077  
Controlling NO<sub>x</sub> from a coal-fired MHD process 21 p0017 A79-10139  
Emission control techniques for alternative fuel  
combustion 21 p0053 A79-12990  
A standard procedure of economic evaluation for  
energy-producing and pollution-abatement  
operations 21 p0064 A79-14109  
State-of-the-art assessment of air pollution  
control technologies for various waste-as-fuel  
processes 21 p0064 A79-14111  
Pollution perspective for geothermal energy  
development 21 p0064 A79-14114  
Recent operating experience of the Wellman-Lord  
FGD process on a coal-fired boiler --- flue gas  
desulfurization 21 p0065 A79-14120  
The Research-Cottrell/Bahco SO<sub>2</sub> and particulate  
removal system at Rickenbacker Air Force Base 21 p0065 A79-14122  
Particulate control for coal-fired industrial  
boilers 21 p0065 A79-14123  
The direct reduction of sulfur dioxide 21 p0065 A79-14124  
Simultaneous nitrogen oxides and sulfur dioxide  
removal by absorption-reduction scrubbing 21 p0066 A79-14125  
Correlations of catalytic combustor performance  
parameters 21 p0081 A79-14956  
Environmental effects of burning solid waste as fuel 21 p0082 A79-15115  
Shock tube studies of coal devolatilization 21 p0083 A79-15247  
Particulate and sulfur oxide control options for  
conventional coal combustion 21 p0092 A79-15883  
Coal-based electricity and air pollution control -  
A case for solvent refined coal 21 p0096 A79-15922  
Commercialization of fluidized-bed combustion  
systems by the State of Ohio 21 p0096 A79-15923  
Clean Air Act amendments of 1977 and the impact on  
control efforts 21 p0097 A79-16091  
Protection of the biosphere --- MHD power stations  
pollution reduction 21 p0105 A79-16483  
The impact of advanced technology on the future  
electric energy supply problem 21 p0112 A79-16736  
Energy requirements of a limestone FGD system ---  
Flue Gas Desulfurization 21 p0114 A79-16747

# SUBJECT INDEX

# POLYCRYSTALS

Reducing inefficiency and emissions of large steam generators in the United States 21 p0114 A79-17075

An analysis of air pollution control costs in N.S.W. --- New South Wales, Australia 21 p0115 A79-17228

Advanced emissions control and test facility of the Electric Power Research Institute 21 p0115 A79-17249

The influence of lead compounds on automotive exhaust catalysts 21 p0116 A79-17253

Advances in fluidized bed gasification process development 21 p0145 A79-17633

Assessment of current flue gas desulfurization technology 21 p0145 A79-17637

MHD power generation 21 p0146 A79-17638

A survey of particulate collection devices for coal-fired boilers 21 p0147 A79-17645

Emission control for SO<sub>2</sub> - An update [ASME PAPER 78-JPGC-PWR-11] 21 p0150 A79-18097

Operating experience with three 20 MW prototype flue gas desulfurization processes [ASME PAPER 78-JPGC-PWR-12] 21 p0150 A79-18098

Operation and emission of a stoker-fired boiler while burning refuse derived fuel and coal mixtures [ASME PAPER 78-WA/APC-2] 21 p0158 A79-19735

Modification of electrostatic precipitator performance by use of fly-ash conditioning agents [ASME PAPER 78-WA/APC-3] 21 p0158 A79-19736

Combustion modifications for the control of air pollutant emissions from coal fired utility boilers [ASME PAPER 78-WA/APC-7] 21 p0158 A79-19738

Combustion modification pollutant control techniques for industrial boilers - The influence of fuel oil properties and atomization parameters [ASME PAPER 78-WA/APC-13] 21 p0159 A79-19742

Hydrogen enrichment for low-emission jet combustion 22 p0244 A79-21347

Tropospheric conduits --- for pollution abatement and energy production 22 p0266 A79-24275

A model for coal fly ash filtration 22 p0296 A79-28389

Electrostatic precipitation tests with fuel oil ash 22 p0296 A79-28390

The application of indirectly fired open cycle gas turbine systems utilizing atmospheric pressure fluidized bed combustors to industrial cogeneration situations [ASME PAPER 79-GT-16] 22 p0306 A79-30510

Soot and the combined cycle boiler [ASME PAPER 79-GT-67] 22 p0307 A79-30533

Emissions and economy potential of prechamber stratified charge engines [SAE PAPER 790436] 22 p0315 A79-31374

A new combustion system in the three-valve stratified charge engine [SAE PAPER 790439] 22 p0316 A79-31376

Particulate control mobile test units: Third year's operation [PB-283657/5] 21 p0178 A79-10603

Pollution control guidance for geothermal energy development [PB-282546/1] 21 p0178 A79-10604

Nitrogen oxide air pollution. Volume 2, part 1: Control technology. A bibliography with abstracts [NTIS/PS-78/0971/8] 21 p0199 A79-12591

Evaluations of novel particulate control devices [PB-283973/6] 21 p0159 A79-12601

Investigation of turbo-dyne energy chamber (G.E. value trademark): An air bleed device [PB-285381/0] 21 p0217 A79-14397

Energy requirements of present pollution control technology [PB-286231/6] 21 p0223 A79-14643

Assessment of coal cleaning technology [PB-287091/3] 22 p0330 A79-16139

Oil pollution reports, volume 5, number 2 --- bibliographies [PB-287071/5] 22 p0336 A79-16437

Environmental assessment for residual oil utilization [PB-286982/4] 22 p0336 A79-16446

Methods for the control of environmental damage caused by mining energy producing materials 22 p0347 A79-18359

Interagency coal cleaning technology development 22 p0347 A79-18361

Environmental assessment data base for high-Btu gasification technology. Volume 1: Technical discussion [PB-288602/6] 22 p0350 A79-18487

Environmental assessment data base for high-Btu gasification technology. Volume 3: Appendices D, E, and F [PB-288604/2] 22 p0350 A79-18489

Water-related environmental effects in fuel conversion, volume 1. Summary [PB-288313/0] 22 p0351 A79-18834

Water-related environmental effects in fuel conversion. Volume 2: Appendices [PB-288874/1] 22 p0356 A79-19496

Evaluation of dry sorbents and fabric filtration for PGD (Flue Gas Desulfurization) [PB-289921/9] 22 p0373 A79-21661

Environmental assessment: Source test and evaluation report, Chapman low-Btu gasification [PB-289940/9] 22 p0373 A79-21662

Pollution control guidelines for coal refuse piles and slurry ponds [PB-291369/7] 22 p0373 A79-21682

**POLLUTION MONITORING**

Ambient air quality assessment of the Synthane coal gasification pilot plant, six month study /August 1976-January 1977/ 21 p0064 A79-14113

Joint Conference on Sensing of Environmental Pollutants, 4th, New Orleans, La., November 6-11, 1977, Proceedings 21 p0082 A79-15023

The impact of a coal fired power plant on ambient sulfur dioxide levels 21 p0082 A79-15032

On the depletion of ambient ozone by a rural coal-fired power plant near Portage, Wisconsin [PB-289940/9] 21 p0082 A79-15052

The circumsolar measurement program - Assessment of the effects of atmospheric scattering on solar energy conversion 21 p0082 A79-15077

Coupled heat and organic wastes stream pollution 21 p0086 A79-15602

A methodology for assessing the potential impact on air quality resulting from geothermal resource development in the Imperial Valley 21 p0116 A79-17262

The measurement of the sulfuric acid and sulfate content of particulate matter resulting from the combustion of coal and oil 21 p0156 A79-19219

Real-time, continuous measurement of automotive sulfuric acid emissions 21 p0156 A79-19359

Tests of various coals, coal-oil mixtures and refuse derived fuels in an experimental test facility [ASME PAPER 78-WA/APC-12] 21 p0158 A79-19741

Emissions from pressurized fluidized-bed combustion processes 22 p0261 A79-23640

Energy-related pollutants in the environment: The use of short-term for mutagenicity in the isolation and identification of biohazards [CONF-780121-2] 21 p0192 A79-11568

EPA program status report: Oil shale [PB-284480/1] 21 p0211 A79-13548

**POLYCRYSTALS**

Polycrystalline CdSe-based photo-electrochemical cells 21 p0037 A79-11785

Recent progress in thin film polycrystalline solar cells based on cadmium sulfide 21 p0042 A79-11966

High efficiency solar cells based on indium phosphide 21 p0042 A79-11968

# POLYESTER RESINS

# SUBJECT INDEX

A diagnostic study on the polycrystalline nature and its relationship with the yield of CdS solar cell  
21 p0125 A79-17361

**POLYESTER RESINS**  
Filon panels - A technical report --- fiberglass reinforced plastics for solar collectors  
21 p0031 A79-10403

**POLYETHYLENES**  
Form-stable, crystalline polymer pellets for thermal energy storage  
21 p0013 A79-10107

**POLYMER PHYSICS**  
Progress in solid polymer electrolyte water electrolysis --- for large-scale hydrogen production  
22 p0289 A79-27653

**POLYMERIC FILMS**  
/SN/x-GaAs polymer-semiconductor solar cells  
21 p0154 A79-18504  
The thermomechanical behavior of polyvinyl butyral film and its effect on focal stability of a solar mirror-laminate  
22 p0239 A79-20824  
Study of the spectral characteristics of metallized polymer films for production of solar concentrators  
22 p0297 A79-28672

**POLYMERS**  
Evaluation and optimization of Solid Polymer Electrolyte (SPE) fuel cells [AD-A058380]  
21 p0206 A79-13505

**POPULATION INVERSION**  
Progress in nuclear-pumped lasers  
21 p0110 A79-16627

**POROUS MATERIALS**  
Combustion of porous particles --- coal for MHD generators  
21 p0049 A79-12708

**POSITION (LOCATION)**  
High accuracy off-shore position finding using the GEOLIE satellite based system  
22 p0329 A79-15932

**POSITION ERRORS**  
Effects of pointing errors on receiver performance for parabolic dish solar concentrators  
21 p0020 A79-10167  
Efficiency degradation due to tracking errors for point focusing solar collectors [ASME PAPER 78-WA/SOL-4]  
21 p0162 A79-19837

**POSITIONING DEVICES (MACHINERY)**  
Flexed beams in central receiver heliostat drives [ATAA PAPER 78-1755]  
21 p0060 A79-13856  
A simple solar tracking system --- manually adjusted rotating shaft for solar concentrator positioning  
21 p0136 A79-17457

**POTABLE WATER**  
Prototype solar heating and cooling systems including potable hot water [NASA-CR-150850]  
21 p0205 A79-13498

**POTASSIUM**  
Lithium and potassium heat pipes for thermionic converters  
21 p0013 A79-10113  
Catalytic gasification predevelopment research  
21 p0029 A79-10246  
Absorption of solar radiation by alkali vapors --- for efficient high temperature energy converters  
21 p0108 A79-16612

**POTASSIUM COMPOUNDS**  
Vaporization of drops of a melt of potassium carbonate in a medium of combustion products  
21 p0167 A79-20411  
Catalytic effect of Ni and K<sub>2</sub>CO<sub>3</sub> in the gasification of carbon and coal  
22 p0364 A79-21215

**POTENTIAL FIELDS**  
Effects of position of output electrodes in entrance region of open-cycle diagonal type MHD generator  
21 p0153 A79-18468  
Three-dimensional effects of electrode configuration on diagonal MHD generator performance  
22 p0283 A79-26523

**POTENTIAL FLOW**  
The interaction of the wind field with a horizontal axis wind turbine  
22 p0278 A79-26177

**POWDER (PARTICLES)**  
Study of the dynamics of the materials seltling process for a solar furnace  
21 p0167 A79-20359

**POWER CONDITIONING**  
Power distribution study for a 5-GW space power satellite  
21 p0002 A79-10026  
Solar furnace type high power density thermoelectric generator  
21 p0027 A79-10229  
Proposals for power conditioning systems of high power communication satellites  
21 p0033 A79-10897  
Space power technology - Current status and future development trends --- for powering spacecraft [DGLR PAPER 78-167]  
21 p0063 A79-14054  
Progress in laser-fusion research  
21 p0070 A79-14464  
Energy sources and conventional magnets --- for tokamak experiment Power Reactor toroidal field  
21 p0079 A79-14791  
Control of wind turbine generators connected to power systems  
21 p0086 A79-15574  
Operation and control of wind-electric systems  
21 p0086 A79-15575  
Inverter systems --- for MHD power stations  
21 p0106 A79-16486  
Economic prospects for the application of new electric energy storage devices  
22 p0246 A79-21490  
Optimizing the conversion mode for solar energy  
22 p0258 A79-23125  
Contribution to the development of wind energy systems using static power electronic converters  
22 p0286 A79-26958  
Alternative power-generation systems  
21 p0169 A79-10129  
Satellite Power Systems (SPS) concept definition study. Volume 3: SPS concept evolution [NASA-CR-158066]  
21 p0225 A79-15138  
Satellite Power Systems (SPS) concept definition study. Volume 2: SPS system requirements [NASA-CR-150681]  
22 p0330 A79-16037  
Comparative cost analyses: Total flow vs other power conversion systems for the Salton Sea Geothermal Resource [UCRL-52589]  
22 p0342 A79-17337  
Power coupling alternatives for the NEP thermionic power system [NASA-CR-158372]  
22 p0367 A79-21547

**POWER EFFICIENCY**  
Coal-fired gas turbine power cycles with steam injection  
21 p0004 A79-10042  
Mechanical efficiency of the Stirling cycle machine with rhombic drive  
21 p0025 A79-10208  
The influence of blade camber on the output of vertical-axis wind turbines  
21 p0045 A79-12242  
Output power variations with solar power satellites  
21 p0067 A79-14267  
Generalized wind characteristics and their effect on wind turbine output  
21 p0068 A79-14294  
Generic power performance estimates for wind turbines  
21 p0068 A79-14295  
MHD power plant characteristics  
21 p0105 A79-16480  
Technical and economic aspects of open-cycle MHD power plants  
21 p0105 A79-16482  
Efficiency of conventional silicon solar cells  
21 p0125 A79-17362  
Efficiency improvement by means of multicomponent processes - Improvement of the efficiency of heat-power transformation by means of an employment of Clausius-Rankine sorption processes  
21 p0164 A79-19975  
The effect of the dispersion of the characteristics of solar cells in large systems  
22 p0285 A79-26827



# SUBJECT INDEX

# PROCESS CONTROL (INDUSTRY)

- Efficiency studies about Daihatsu engine/electric hybrid system  
[SAE PAPER 790013] 22 p0314 A79-31352
- Parametric study of two planar high power flexible solar array concepts  
[NASA-CR-157841] 21 p0205 A79-13501
- POWER LINES**  
Power cables to accommodate the motions of an OTEC plant  
21 p0101 A79-16251
- POWER PLANTS**  
Geothermal preheating in fossil-fired steam power plants  
21 p0014 A79-10118
- Powerplant integration - The application of current experience to future developments  
[ASME PAPER 78-GT-113] 21 p0032 A79-10788
- Development of solar thermal power plants  
21 p0057 A79-13641
- Solar thermal power stations  
21 p0057 A79-13644
- Stabilization of power plant scrubbing slurries and fine coal refuse with the additive Calcilox  
21 p0063 A79-14107
- The Research-Cottrell/Bahco SO<sub>2</sub> and particulate removal system at Rickenbacker Air Force Base  
21 p0065 A79-14122
- Integrated low Btu gasification, combined cycle plant considerations and control  
21 p0094 A79-15905
- Cycle optimization for a solar turbo-pack --- turbine water pump utilizing Rankine cycle  
21 p0141 A79-17500
- Medium capacity heliothermal power stations  
21 p0142 A79-17507
- History and development of condensers at the Geysers geothermal power plant  
[ASME PAPER 78-JPGC-PWR-18] 21 p0150 A79-18099
- Experimental investigation of the joint operation of wind and solar plants  
21 p0167 A79-20358
- An ocean thermal difference power plant in the Canadian Arctic  
22 p0318 A79-31415
- Preliminary summary of the ETP conceptual studies  
[NASA-TM-78999] 21 p0183 A79-11478
- An assessment of thermal energy storage and waste heat dissipation with total energy systems for MIT  
[AD-A059061] 21 p0205 A79-13502
- POWER SPECTRA**  
Power cycles and working fluids for low temperature heat sources  
22 p0332 A79-16268
- POWER SUPPLIES**  
Satellite Power Systems (SPS) concept definition study. Volume 2: SPS system requirements  
[NASA-CR-150681] 22 p0330 A79-16037
- POWER SUPPLY CIRCUITS**  
High-current power leads for tokamak fusion reactor superconducting magnets  
21 p0085 A79-15318
- Closed Loop solar array-ion thruster system with power control circuitry  
[NASA-CASE-LEW-12780-1] 22 p0357 A79-20179
- POWER TRANSMISSION**  
The use of lasers for the transmission of power  
21 p0109 A79-16621
- PRECAMBRIAN PERIOD**  
Continental geotherms during the Archean --- heat production in ancient earth crust  
22 p0269 A79-24620
- PRECIPITATORS**  
Advanced emissions control and test facility of the Electric Power Research Institute  
21 p0115 A79-17249
- PREDICTION ANALYSIS TECHNIQUES**  
A theoretical method for the prediction of monthly mean solar radiation parameters  
21 p0022 A79-10183
- Wave energy conversion in a random sea  
21 p0030 A79-10252
- Effects of weather and pollution on incident solar energy - Basic measurements leading to computer models  
21 p0065 A79-14117
- A methodology for evaluating the effectiveness of energy conservation programs  
21 p0072 A79-14684
- System for projecting the utilization of renewable resources. SPURR methodology  
[ERHQ/2322-77/4] 21 p0174 A79-10538
- PREDICTIONS**  
Energy and the economy  
[EPRI-EA-620-VOL-1] 21 p0189 A79-11539
- PREMIXED FLAMES**  
Stability of combustion in the combustion chamber of an MHD generator  
21 p0049 A79-12691
- Influences on exhaust emissions from automotive gas turbines  
[ASME PAPER 78-GT-85] 22 p0255 A79-22338
- PRESSURE EFFECTS**  
Toroidal high-beta systems  
21 p0070 A79-14462
- The plateau pressure of RE Hf5 and RE Co5 hydrides --- in hydride formation  
22 p0250 A79-21698
- PRESSURE GRADIENTS**  
The use of ocean energy - A hydrostatic motor  
22 p0288 A79-27391
- PRESSURE HEADS**  
Power plant systems based on solar energy --- powered by sea water evaporation-produced osmotic pressure head mechanical energy  
21 p0142 A79-17508
- PRESSURE MEASUREMENTS**  
Differential pressure measurements in high temperature environments  
21 p0144 A79-17599
- Fuel content characterization and pressure retention measurements of DT-filled laser fusion microballoon targets  
22 p0258 A79-23034
- Pressure measurements on wind tunnel models of the Aylesbury experimental house  
22 p0300 A79-29372
- PRESSURE OSCILLATIONS**  
The oscillating water column wave-energy device  
22 p0252 A79-22223
- PRESSURE RECOVERY**  
On supersonic and subsonic diffusers for magnetohydrodynamic generator applications  
22 p0279 A79-26186
- PRESSURIZING**  
Assessment of the potential of generating power from aqueous saline solutions by means of Osmo-Hydro Power systems  
21 p0016 A79-10133
- PRIMARY BATTERIES**  
Evaluation of methods for analyzing silver-zinc cells  
21 p0010 A79-10085
- Discharge reaction mechanisms in Li/SOCl<sub>2</sub> cells  
22 p0305 A79-30331
- PRISMS**  
Ideal prism solar concentrators  
21 p0149 A79-18023
- PROBABILITY THEORY**  
Bail risk model for solar collectors  
21 p0098 A79-16103
- PROCESS CONTROL (INDUSTRY)**  
Coal desulfurization test plant status - July 1977 --- utilizing Meyers leach process  
21 p0044 A79-12118
- Dynamic model of an industrial plant manufacturing a variety of products  
21 p0051 A79-12957
- Status and outlook of the Exxon Donor Solvent coal liquefaction process development  
21 p0092 A79-15889
- Solar Total Energy Control Data Acquisition System  
21 p0144 A79-17618
- Master control and data system for the 5MW Solar Thermal Test Facility  
21 p0148 A79-17620
- Burn coal cleanly in a fluidized bed - The key is in the controls  
22 p0282 A79-26374
- Catalytic hydrodesulfurization and liquefaction of coal - Batch autoclave studies  
22 p0282 A79-26465
- Coal gasification studies. I - Single stage complete gasification of coal using water as the hydrogen source  
22 p0283 A79-26466

# PROCUREMENT POLICY

# SUBJECT INDEX

- Sampling and analysis of synthetic fuel processes  
--- coal gasification and liquefaction effluent analysis 22 p0284 A79-26538
- Standards of Practice Manual for the solvent refined coal liquefaction process [PB-283028/9] 21 p0178 N79-10595
- Process feasibility study in support of silicon material task 1 [NASA-CR-158034] 21 p0219 N79-14541
- PROCUREMENT POLICY**
- Assessing environmental costs of energy procurement 21 p0071 A79-14682
- The national energy plan: Options under assumptions of national security threat --- economic impact procurement policy, and resources management [H-PRINT-95-48] 21 p0228 N79-15398
- PRODUCT DEVELOPMENT**
- Review of industrial participation in the ANL lithium/iron sulfide battery development program --- for electric vehicles 21 p0010 A79-10086
- Recent advances in Na/S cell development - A review 22 p0246 A79-21488
- A solar collector thermal performance test for developmental programs 22 p0317 A79-31413
- Industrialization study --- impact of government incentives and barriers on decision making in the industrial production of photovoltaics [NASA-CR-157953] 21 p0200 N79-12970
- Industrialization study, phase 2 --- assessment of advanced photovoltaic technologies for commercial development [NASA-CR-158015] 22 p0333 N79-16351
- Preliminary design package for residential heating/cooling system: Rankine air conditioner redesign [NASA-CR-150871] 22 p0354 N79-19453
- Multistack nickel-hydrogen units 22 p0371 N79-21610
- PRODUCTION ENGINEERING**
- Engineering analysis of in situ liquefaction of coal 21 p0032 A79-10521
- Large, lightweight, replicated mirrors 21 p0043 A79-11976
- Feasibility of rocket propellant production on Mars 21 p0047 A79-12324
- Dynamic model of an industrial plant manufacturing a variety of products 21 p0051 A79-12957
- Status and outlook of the Exxon Donor Solvent coal liquefaction process development 21 p0092 A79-15889
- Production and use of low and medium Btu gas 21 p0095 A79-15912
- Fabrication and assembly considerations for a base load MHD superconducting magnet system 22 p0235 A79-20534
- Practical aspects of designing and manufacturing MHD superconducting base-load magnets in 1988 time frame 22 p0235 A79-20535
- Solar cell collector and method for producing same [NASA-CASE-LEW-12552-2] 21 p0182 N79-11472
- Program THER energy production units of average power and using thermal conversion of solar radiation [NASA-TN-75369] 21 p0183 N79-11474
- Energy analysis [NP-23145] 21 p0187 N79-11513
- Process feasibility study in support of silicon material task 1 [NASA-CR-158034] 21 p0219 N79-14541
- Pilot line report: Development of a high efficiency thin silicon solar cell [NASA-CR-158028] 21 p0219 N79-14548
- Automated array assembly, phase 2 [NASA-CR-158360] 22 p0358 N79-20480
- Phase two of the array automated assembly task for the low cost solar array project [NASA-CR-158359] 22 p0359 N79-20484
- Silicon solar cell process development, fabrication and analysis [NASA-CR-158363] 22 p0359 N79-20485
- Development, testing, and certification of the Northrup, Inc., ML series concentrating solar collector model NSC-01-0732 [NASA-TN-78219] 22 p0371 N79-21618
- Development, testing, and certification of Owens-Illinois model SEC-601 solar energy collector system [NASA-TN-78223] 22 p0371 N79-21620
- PRODUCTION MANAGEMENT**
- Material growth and characterization directed toward improving III-V heterojunction solar cells [NASA-CR-158476] 22 p0367 N79-21543
- PROFILE METHOD (FORECASTING)**
- Outlook for world oil into the 21st century with emphasis on the period to 1990 [EPRI-EA-745] 21 p0181 N79-11454
- PROGRAM VERIFICATION (COMPUTERS)**
- Initial comparison of single cylinder Stirling engine computer model predictions with test results [NASA-TN-79044] 22 p0337 N79-16721
- PROGRAMMED INSTRUCTION**
- Design package for programmable controller and hydronic subsystem [NASA-CR-161151] 22 p0371 N79-21619
- PROJECT MANAGEMENT**
- International project catalog of modular integrated utility systems [PB-283477/8] 21 p0190 N79-11544
- Committee on the challenges of modern society rational use of energy pilot study modular integrated utility system project. Volume 2: Minutes of project meeting [PB-283429/9] 21 p0191 N79-11558
- LSA Low-cost Solar Array project [NASA-CR-158250] 22 p0355 N79-19462
- Evaluation of four energy conservation programs--fiscal year 1977 [PB-288825/3] 22 p0355 N79-19472
- PROJECT PLANNING**
- Solar thermal power systems point-focusing distributed receiver /PFDR/ technology - A project description [AT&A PAPER 78-1771] 21 p0062 A79-13869
- OAST space power technology program 21 p0169 N79-10123
- Satellite power systems program 21 p0169 N79-10128
- An economical approach to space power systems 21 p0170 N79-10139
- Environmental Development Plan (EDP): Solar thermal power systems, 1977 [DOE/EDP-0004] 21 p0187 N79-11522
- OAST Space Theme Workshop. Volume 1: Summary report. 1: Introduction. 2: General observations and some key findings. 3: Follow-on activity. Quick-look comments and working papers [NASA-TN-80001] 21 p0224 N79-15113
- Satellite Power Systems (SPS) concept definition study. Volume 7: SPS program plan and economic analysis [NASA-CR-158068] 21 p0225 N79-15141
- Satellite power systems (SPS) concept definition study. Volume 7: SPS program plan and economic analysis, appendices [NASA-CR-150702] 21 p0225 N79-15142
- Satellite Power System (SPS) program summary [DOE/ER-0022] 22 p0337 N79-16893
- The 25 kW power module evolution study. Part 3: Conceptual designs for power module evolution. Volume 2: Program plans [NASA-CR-161146] 22 p0345 N79-17890
- PROPAGATION MODES**
- Stability criteria for current-driven drift wave eigenmodes --- in tokamaks 22 p0269 A79-24813
- PROPULSION**
- Advanced secondary batteries for electric vehicle propulsion [CONF-780426-2] 21 p0186 N79-11508
- The AGARD propulsion and energetics panel, 1952-1977 [AGARD-AR-111] 22 p0337 N79-16848
- Thermal power systems point-focusing distributed receiver technology project. Volume 1: Executive summary [NASA-CR-158421] 22 p0360 N79-20492

## PROPULSION SYSTEM CONFIGURATIONS

- Impact of future fuel properties on aircraft engines and fuel systems 21 p0036 A79-11600
- NASA research on general aviation power plants [NASA-TN-79031] 21 p0194 N79-12086
- PROPULSION SYSTEM PERFORMANCE**
- Road vehicles with combined, at least partly electrical driving systems and energy supplies 22 p0301 A79-29494
- Developing electric vehicles 22 p0302 A79-29496
- An electric propulsion system for a town and city bus 22 p0302 A79-29499
- Measured effects of flow leakage on the performance of the GT-225 automotive gas turbine engine [ASME PAPER 79-GT-3] 22 p0306 A79-30502
- Study of flywheel energy storage Volume 1: Executive summary [PB-282652/7] 21 p0176 N79-10555
- Study of flywheel energy storage. Systems analysis [PB-282653/5] 21 p0176 N79-10556
- Study of flywheel energy storage. Volume 3: System mechanization [PB-282654/3] 21 p0177 N79-10557
- Study of flywheel energy storage. Volume 5: Vehicle tests [PB-282656/8] 21 p0177 N79-10559
- Engine component improvement and performance retention 21 p0202 N79-13198
- Energy efficient engine: Propulsion system-aircraft integration evaluation [NASA-CR-159488] 22 p0337 N79-16850
- Earth orbital assessment of solar electric and solar sail propulsion systems [NASA-CR-158167] 22 p0345 N79-17898
- PROTECTIVE COATINGS**
- Controlled utilization of coal slag in the MHD topping cycle 21 p0081 A79-14936
- Metallurgical coatings 1978; Proceedings of the Fifth International Conference, San Francisco, Calif., April 3-7, 1978. Volumes 1 & 2 22 p0327 A79-31951
- PROTON IMPACT**
- Spectral characteristics of photoconverters with nonuniform defect distribution in the base 21 p0053 A79-13289
- PROTOTYPES**
- Demonstration and commercial prototype tokamak reactors 21 p0018 A79-10146
- An aperture-augmented prototype power satellite 21 p0046 A79-12268
- Prototype solar heating and cooling systems including potable hot water [NASA-CR-150861] 22 p0334 N79-16372
- PROVING**
- Verification methodology for the DOE-1 building energy analysis computer program [LA-UR-78-1493] 21 p0208 N79-13520
- PUBLIC HEALTH**
- Risk with energy from conventional and nonconventional sources 22 p0266 A79-24151
- A literature review-problem definition studies on selected toxic chemicals. Volume 1: Occupational health and safety aspects of diesel fuel and white smoke generated from it [AD-A056018] 21 p0192 N79-11686
- Health effects associated with diesel exhaust emissions, literature review and evaluation [PB-289817/9] 22 p0364 N79-20727
- PUBLIC LAW**
- Electric and Hybrid Vehicle Act, Public Law 94-413 demonstration program objective and schedule [GPO-98-809] 22 p0351 N79-18810
- PUBLIC RELATIONS**
- Public policy 21 p0179 N79-11011
- PULSE GENERATORS**
- Problems in the development of high-service-life capacitive accumulators --- for fusion reactors 22 p0243 A79-21249

- Pulsed-power research and development in the USSR [AD-A056635] 21 p0193 N79-11859
- PULSED LASERS**
- Hybrid reactor based on laser-induced thermonuclear fusion 21 p0032 A79-10658
- Prepulse damage to targets and alignment verification 22 p0258 A79-23027
- Diagnostics of Shiva Nova high-yield thermonuclear events --- in laser fusion 22 p0285 A79-26747
- Pulsed power supplied for large laser systems [UCRL-80113] 21 p0217 N79-14377
- PUMPING**
- Historical developments of the use of solar energy for pumping irrigation water 21 p0076 A79-14762
- Basic technical and economical aspects of the use of solar energy for pumping irrigation water 21 p0076 A79-14763
- Solar pumping --- thermal and electrical water pumping 21 p0104 A79-16469
- PUMPS**
- Analysis of a direct coupling d.c. motor and a photovoltaic converter 21 p0046 A79-12272
- Solar energy installations for pumping irrigation water 21 p0066 A79-14260
- Solar water pumping 21 p0066 A79-14266
- 25 kilowatt photovoltaic powered irrigation and grain drying experiment 21 p0143 A79-17519
- Solar irrigation program status 21 p0143 A79-17520
- The development of a 37 kW solar-powered irrigation system 21 p0144 A79-17525
- The use of wave powered systems for desalination - A new opportunity --- seawater pumping for reverse osmosis 21 p0151 A79-18108
- Production of mechanical energy by thermodynamic conversion of solar energy 22 p0310 A79-30999
- The definition of a national program in energy-efficient pump utilization, volume 1 [HCP/W1260-01/1] 21 p0207 N79-13514
- The definition of a national program in energy-efficient pump utilization. Volume 2: Appendices [HCP/W1260-01/2] 21 p0207 N79-13515
- Solar water pumps. Citations from the Engineering Index data base [NTIS/PS-78/1288/6] 22 p0343 N79-17348
- PURIFICATION**
- The use of FeTi-hydride for production and storage of suprapure hydrogen 22 p0250 A79-21700
- PYRAMIDAL BODIES**
- Comparison of the solar concentrating properties of truncated hexagonal, pyramidal and circular cones 21 p0043 A79-11974
- PYRANOMETERS**
- Inclination dependence of pyranometer sensitivity --- for solar collector testing 22 p0295 A79-28154
- PYRITES**
- Applicability of the Meyers process for desulfurization of U.S. coal - A survey of 35 coals --- through chemical leaching 21 p0044 A79-12117
- PYROHELIONETERS**
- Measurement of radiation intensity by means of a pyrheliometer 21 p0055 A79-13623
- PYROLYSIS**
- Coal conversion by flash hydrolysis and hydrogasification 21 p0006 A79-10055
- Theoretical studies of coal pyrolysis in an entrained bed flow reactor 21 p0007 A79-10063
- A copper oxide-copper sulfate water-splitting cycle 21 p0015 A79-10128

## Q FACTORS

- Recovery of oil from oil shale - An overall technological perspective 21 p0073 A79-14698
- Thermal calculations for the reactor of a solar-power unit to produce hydrogen by thermolysis of water 21 p0167 A79-20360
- A theoretical study of wood gasification processes 22 p0257 A79-22923
- Methane formation during the hydrogasification and the gas phase pyrolysis of defined aromatics 22 p0265 A79-23829
- Kinetic modeling of pyrolysis and hydrogasification of carbonaceous materials --- converting wood waste char to clean fuels 21 p0179 A79-11150
- Thermal and kinetic analysis of the pyrolysis of coals 22 p0336 A79-16704

## Q

## Q FACTORS

- Calculation of the Q factor for a two-component tokamak 22 p0324 A79-31763

## Q SWITCHED LASERS

- Performance of the short-pulse oscillators for Argus and Shiva 21 p0083 A79-15171

## QUEBEC

- The performance of a site built, air heating, vertical collector with snow reflector in Quebec 22 p0319 A79-31423

## QUENCHING (COOLING)

- Heat pulses required to quench a potted superconducting magnet 22 p0236 A79-20538

## R

## RADIAL DISTRIBUTION

- Laser measurements of the radial profiles of the electron temperature and density in the FT-1 tokamak 22 p0244 A79-21430

## RADIAL FLOW

- Nonstationary two-dimensional magnetohydrodynamic flow in a radial channel 22 p0247 A79-21626
- Radial transport in the ELMO Bumpy Torus in collisional regimes 22 p0312 A79-31184

## RADIANT COOLING

- Optimization and design of radiative heat-discharge system for energy unit with Stirling engine --- operating in planetary environment 21 p0166 A79-20348

## RADIANT FLUX DENSITY

- Receiver designs for tower-top solar collector 21 p0135 A79-17450
- Design of solar heating system for winter heating of buildings /A case study/ 21 p0139 A79-17486
- Controlling the radiant flux of a high-temperature solar energy conversion system over two parameters 22 p0296 A79-28669
- Radiation regime of inclined surfaces [WHO-467] 21 p0192 A79-11613

## RADIANT HEATING

- Slag transport models for radiant heater of an MHD system [ASME PAPER 78-WA/HT-21] 21 p0161 A79-19808
- Radiant exchange for a fin and tube solar collector 22 p0271 A79-25066

## RADIATION ABSORPTION

- Absorption of solar radiation by alkali vapors --- for efficient high temperature energy converters 21 p0108 A79-16612
- Thermal analysis of black liquid cylindrical parabolic collector 22 p0295 A79-28354
- Method for making an aluminum or copper substrate panel for selective absorption of solar energy [NASA-CASE-MPS-23518-1] 21 p0182 A79-11469
- Solar evacuated tube collector: Absorption chiller systems simulation [COO-2577-13] 21 p0209 A79-13530

## SUBJECT INDEX

- Proposal for a representation of the quasisteady-state performance of flat-plate collectors [ASSA-SB-B21/77] 22 p0349 A79-18461
- RADIATION DAMAGE**
- The NTS-2 satellite solar cell experiment 21 p0001 A79-10016
- Materials problems and possible solutions for near term tokamak fusion reactors 21 p0079 A79-14790
- RADIATION DISTRIBUTION**
- Fundamentals of mathematical modeling of solar-radiation regime energy structure 21 p0166 A79-20352
- Isotropic distribution approximation in solar energy estimations --- diffuse insolation on tilted surface 22 p0262 A79-23753
- Flux-redistribution in the focal region of a planar Fresnel ring mirror --- solar furnace design 22 p0263 A79-23764
- On the use of synoptic weather map typing to define solar radiation regimes 22 p0272 A79-25392
- RADIATION EFFECTS**
- Fuel technology and the environment --- nuclear reactor caused radiation effects and transmutation 21 p0079 A79-14787
- Response of a solar cell to intense and nonuniform illumination when used with solar concentrators 21 p0125 A79-17357
- Calculation of the external electromagnetic field of closely spaced MHD machines 22 p0298 A79-29285
- RADIATION HAZARDS**
- Some perspectives on research into the biological response to non-ionizing electromagnetic radiation --- relation to SETI, SPS, and other government projects 22 p0271 A79-24879
- RADIATION MEASUREMENT**
- The use of a sort of slide rule for the quick determination of solar irradiation of surfaces and through double glazing of arbitrary orientation and different inclination 21 p0055 A79-13625
- Calibration standards and field instruments for the precision measurement of insolation 21 p0076 A79-14765
- Measurement of solar radiation for energy conversion 21 p0119 A79-17305
- Design of radiometer for measurement of total and net exchange solar radiation 21 p0119 A79-17307
- Measurement and modelling of shortwave radiation on inclined surfaces 22 p0242 A79-21062
- Thermal converters with transverse thermoelectromotive forces 22 p0256 A79-22847
- RADIATION MEASURING INSTRUMENTS**
- Facility with sectioned photoreceiver and laser radiator for determining solar radiation concentrator accuracy characteristics 21 p0054 A79-13292
- Results of measurements of solar radiation on surfaces of different orientations 21 p0055 A79-13622
- Measurement of radiation intensity by means of a pyrheliometer 21 p0055 A79-13623
- New instrumentation for high temperature and hemispherical measurements of selective surfaces --- for solar energy conversion 22 p0294 A79-28152
- Specularity measurements for solar materials 22 p0294 A79-28153
- RADIATIVE HEAT TRANSFER**
- Flame emissivities - Alternative fuels 21 p0052 A79-12984
- On the optimisation of Trombe wall solar collectors [ASME PAPER 78-WA/SOL-13] 21 p0163 A79-19845
- Estimating heat loads on multistage thermoelectric heat pumps 22 p0260 A79-23614

# SUBJECT INDEX

# RAPID TRANSIT SYSTEMS

- Heat exchanges and columnar growth in electron-beam evaporation of silicon films for solar cell applications 22 p0272 A79-25084
- Cavity-type surfaces for solar collectors 22 p0283 A79-26497
- RADIO FREQUENCY HEATING**
- Present status of two R.F. heating schemes - I.C.E.H. and L.H.E.H. --- Ion Cyclotron Resonant Heating and Lower-Hybrid Resonant Heating of plasma 21 p0071 A79-14467
- The advanced thermionic converter with microwave power as an auxiliary ionization source 21 p0153 A79-18470
- RF-heating in stationary systems --- of toroidal plasma in tokamaks 22 p0271 A79-24864
- Lower hybrid resonance heating --- of tokamak plasma 22 p0271 A79-24865
- RADIO FREQUENCY INTERFERENCE**
- Solar Power Satellite (SPS) pilot beam and communication link subsystem investigation study, phase 1 --- ionospheric propagation, radio frequency interference, and microwave transmission [NASA-CR-161161] 22 p0345 A79-17896
- RADIO TRANSMITTERS**
- Power supplies for Arctic radio repeater systems [AD-A061609] 22 p0339 A79-17118
- RADIOACTIVE ISOTOPIES**
- Selenide isotope generator for the Galileo mission 21 p0022 A79-10185
- Cooling radioisotope thermoelectric generators in the Shuttle 21 p0023 A79-10186
- Selenide technology evaluation program at JPL 21 p0026 A79-10222
- Analytical predictions of selenide RTG power degradation 21 p0026 A79-10223
- Recent terrestrial and undersea applications of radioisotope thermoelectric generators /RTGs/ 21 p0027 A79-10226
- Radioisotope-powered free-piston Stirling engine for space applications [IAP PAPER 78-42] 21 p0034 A79-11217
- Analysis of radioactive contaminants in by-products from coal-fired power plant operations [PB-286365/2] 21 p0232 A79-15473
- RADIOISOTOPE BATTERIES**
- Copper/water axially-grooved heat pipes for RTG applications 21 p0023 A79-10188
- Brayton Isotope Power System - The versatile dynamic power converter --- for spacecraft 21 p0023 A79-10190
- Melting multifoil insulation for KIPS emergency cooling --- Kilowatt Isotope Power System 21 p0023 A79-10191
- Development of a 1 kW/e/ isotope fueled Stirling cycle power system 21 p0025 A79-10210
- Determining the reliability of radioisotope thermoelectric generators /RTGs/ designed for terrestrial and undersea applications 22 p0261 A79-23622
- Recent terrestrial and undersea applications of radioisotope thermoelectric generators /RTGs/ 22 p0261 A79-23623
- RADIONETERS**
- Design of radiometer for measurement of total and net exchange solar radiation 21 p0119 A79-17307
- RAIL TRANSPORTATION**
- Energy efficiency in the transport sector 21 p0054 A79-13574
- Breakdown of rapid rail energy costs - A study of three systems 21 p0068 A79-14323
- Total energy and labor requirements for an electric commuter railroad 21 p0068 A79-14325
- Optimal control of on-board and station flywheel storage for rail transit systems 21 p0148 A79-17822
- Energy requirements of the rail mode [ASME PAPER 78-BT-1] 21 p0150 A79-18085
- Optimal control of on-board and station flywheel storage for rail transit systems [ASME PAPER 78-WA/DSC-32] 21 p0159 A79-19771
- The influence of systems and operations on rapid rail energy utilization 22 p0299 A79-29338
- The impact of aeronautical sciences on other modes of transport 22 p0325 A79-31915
- RAMAN SPECTRA**
- Stimulated Raman scatter in laser fusion target chambers 21 p0155 A79-18794
- RANDOM SAMPLING**
- Phase one/base data for the development of energy performance standards for new buildings: Sample design [PB-286903/0] 22 p0331 A79-16150
- RANKINE CYCLE**
- Analysis and design of an 18-ton solar-powered heating and cooling system 21 p0019 A79-10156
- Combined cycle gas turbine for an automobile application 21 p0019 A79-10157
- Simulation of solar powered Rankine cycle systems 21 p0022 A79-10179
- Melting multifoil insulation for KIPS emergency cooling --- Kilowatt Isotope Power System 21 p0023 A79-10191
- A Stirling engine heat pump system 21 p0024 A79-10206
- A high temperature Rankine binary cycle for ground and space solar engine applications 21 p0108 A79-16613
- Cycle optimization for a solar turbopack --- turbine water pump utilizing Rankine cycle 21 p0141 A79-17500
- Design and performance of 1/4 H.P. solar power unit 21 p0141 A79-17503
- Application of turbopack in solar energy systems 21 p0141 A79-17504
- Conceptual design of large heat exchangers for ocean thermal energy conversion [ASME PAPER 78-WA/HT-32] 21 p0161 A79-19813
- Efficiency improvement by means of multicomponent processes - Improvement of the efficiency of heat-power transformation by means of an employment of Clausius-Rankine sorption processes 21 p0164 A79-19975
- Use of organic fluids in solar turbines 22 p0269 A79-24621
- Optimum power plant capacity of ocean-based ocean thermal energy conversion systems 22 p0297 A79-28922
- The combined reheat gas turbine/steam turbine cycle. I - A critical analysis of the combined reheat gas turbine/steam turbine cycle [ASME PAPER 79-GT-7] 22 p0306 A79-30505
- Solar Rankine engines - Examples and projected costs [ASME PAPER 79-SOL-3] 22 p0307 A79-30541
- Rankine cycle machines for solar cooling [NASA-TN-78196] 21 p0173 A79-10524
- Preliminary design package for residential heating/cooling system: Rankine air conditioner redesign [NASA-CR-150871] 22 p0354 A79-19453
- RANKINE-HUGONIOY RELATION**
- Mathematical models of direct initiation of unconfined gas phase detonations --- hazards of LNG/air clouds from spills [AIAA PAPER 79-0289] 21 p0157 A79-19649
- RAPID TRANSIT SYSTEMS**
- Breakdown of rapid rail energy costs - A study of three systems 21 p0068 A79-14323
- Optimal control of on-board and station flywheel storage for rail transit systems [ASME PAPER 78-WA/DSC-32] 21 p0159 A79-19771
- Application of kinetic energy storage to transportation systems --- flywheels 22 p0299 A79-29337
- The influence of systems and operations on rapid rail energy utilization 22 p0299 A79-29338
- The application of optimal control theory hybrid electric transit systems [AD-A059365] 21 p0220 A79-14559

# RARE EARTH COMPOUNDS

# SUBJECT INDEX

## RARE EARTH COMPOUNDS

- Magnetic and electrical properties of rare earth and rare earth intermetallic hydrides 22 p0249 A79-21692
- Hydrogen absorption in rare earth intermetallic compounds 22 p0249 A79-21693
- Hydrides of rare earth-nickel compounds - Structure and formation enthalpies 22 p0250 A79-21697
- The plateau pressure of RE Ni5 and RE Co5 hydrides --- in hydride formation 22 p0250 A79-21698
- Rare earth and actinide intermetallics as hydrogenation catalysts 22 p0251 A79-21713

## RARE GASES

- Experimental investigation on the discharge structure in a noble gas MHD generator [TH-78-P-79] 22 p0350 N79-18758

## RAREFIED PLASMAS

- Past penetration of a magnetic field into a low-density plasma 22 p0244 A79-21432
- Electrons of high perpendicular energy in the low-density regime of tokamaks 22 p0270 A79-24852

## RATIONS

- Proposed standby gasoline rationing plan. Economic and regulatory analysis draft [DOE/EHA-0009] 21 p0214 N79-13934

## RAY TRACING

- Laser ray trace tester for parabolic trough solar collectors 21 p0144 A79-17619
- Wave reflection from the lower hybrid surface - A toroidal effect --- in tokamaks 22 p0255 A79-22427
- A ray-tracing analysis of fast-wave heating of tokamaks 22 p0313 A79-31186

## RAYLEIGH DISTRIBUTION

- A comparison of the Weibull and Rayleigh distributions for estimating wind power potential 21 p0045 A79-12243
- An analytical expression for the specific output of wind turbine generators 22 p0273 A79-25720

## REACTION KINETICS

- Catalytic gasification predevelopment research 21 p0029 A79-10246
- Catalytic coal gasification exploratory research program 21 p0030 A79-10247
- Electrochemical-ellipsometric studies of oxide films formed on nickel during oxygen evolution 21 p0038 A79-11799
- O2 reduction kinetics in concentrated acids --- in fuel cells 21 p0038 A79-11809
- Combustion chemistry of chain hydrocarbons 21 p0052 A79-12986
- Kinetics of nitric oxide formation in combustion 21 p0053 A79-12989
- Shock-tube measurements of induction and post-induction rates for low-Btu gas mixtures --- derived from shale oil retorting and coal gasification 21 p0083 A79-15245
- Solar fuels --- photochemical reaction kinetics and energy storage 21 p0149 A79-18009
- Energy storage using the reversible oxidation of barium oxide 22 p0242 A79-21169
- Kinetics of hydrogen absorption and desorption --- for energy storage 22 p0248 A79-21687
- Feasible operating regions for moving bed coal gasification reactors 22 p0297 A79-28983
- Combustion kinetics of selected aromatic hydrocarbons [AD-A059381] 21 p0215 N79-14184
- Thermal and kinetic analysis of the pyrolysis of coals 22 p0336 N79-16704

- Alternative hydrocarbon fuels: Combustion and chemical kinetics --- synthetic aircraft fuels [AD-A061050] 22 p0338 N79-17011

## REACTION WHEELS

- Design and applications of flywheels. Citations from the NTIS data base [NTIS/PS-78/0997/3] 21 p0190 N79-11550
- Design and applications of flywheels. Citations from the engineering index data base [NTIS/PS-78/0998/1] 21 p0190 N79-11551

## REACTIVITY

- Limestone SO2 reactivity and causes for reactivity loss during multi cycle utilization 21 p0065 A79-14121

## REACTOR DESIGN

- Fusion-Fission Energy Systems 21 p0017 A79-10144
- Doublet III design and construction --- Tokamak fusion research device 21 p0018 A79-10145
- Demonstration and commercial prototype tokamak reactors 21 p0018 A79-10146
- Mirror fusion reactors 21 p0018 A79-10148
- Overview of inertial confinement fusion reactor designs 21 p0018 A79-10149
- CO2-laser fusion 21 p0018 A79-10150
- Compact fusion reactors using controlled imploding liners 21 p0018 A79-10151
- The fast power cycle for fusion reactors 21 p0018 A79-10152
- Commercial applications of thermionic conversion using a fusion reactor energy source - A preliminary assessment 21 p0026 A79-10219
- The efficiencies of thermochemical energy transfer 21 p0054 A79-13575
- On the ion energy balance in TFR with and without neutral injection heating 21 p0069 A79-14452
- Recent results from the PLT tokamak 21 p0069 A79-14453
- Progress in tokamak experimental research in the Soviet Union 21 p0069 A79-14455
- Fusion reactor problems --- plasma confinement and interface engineering 21 p0071 A79-14468
- Tokamak reactors for breakeven: A critical study of the near-term fusion reactor program --- Book 21 p0077 A79-14776
- The 'FINTOR 1' design - A minimum size tokamak experimental reactor 21 p0078 A79-14782
- Philosophy and physics of predemonstration fusion devices 21 p0078 A79-14783
- Characteristics of a predemonstration fusion device 21 p0078 A79-14784
- Predemonstration fusion devices - Research and development needs 21 p0078 A79-14785
- Superconducting magnets - Some fundamentals and their state of the art 21 p0079 A79-14788
- Superconducting magnet systems in EPR designs --- Experimental Power Reactor 21 p0079 A79-14789
- Materials problems and possible solutions for near term tokamak fusion reactors 21 p0079 A79-14790
- Energy sources and conventional magnets --- for tokamak experiment Power Reactor toroidal field 21 p0079 A79-14791
- Auxiliary heating in breakeven tokamaks 21 p0079 A79-14792
- The impact of servicing requirements on tokamak fusion reactor design 21 p0079 A79-14793
- High-current power leads for tokamak fusion reactor superconducting magnets 21 p0085 A79-15318
- Self-adjusting laser-target system for laser fusion 21 p0086 A79-15625

## SUBJECT INDEX

## REFRACTIVITY

- Energy storage for tokamak reactor cycles ---  
during downtime for periodic plasma quench and  
reignition 21 p0111 A79-16727
- Radially resolved measurements of 'q' on the  
adiabatic toroidal compressor tokamak --- safety  
factor 21 p0155 A79-18830
- Design of a D-shaped toroidal field coil 21 p0156 A79-19083
- Nuclear characteristics of D-D fusion reactor  
blankets - Technical data 21 p0162 A79-19826
- Conceptual design of a superconducting tokamak -  
'TORUS II SUPRA' 22 p0236 A79-20543
- SLPX - Superconducting Long-Pulse Tokamak Experiment 22 p0237 A79-20557
- Minimum-average-B wells in linked magnetic mirror  
fields --- for plasma control in fusion reactors 22 p0252 A79-22237
- Particle orbits in field-reversed mirrors --- for  
plasma confinement in fusion reactor 22 p0253 A79-22239
- An overview of design space for small fusion targets 22 p0253 A79-22241
- Energy for the long run - Fission or fusion 22 p0256 A79-22760
- The potential of fusion reactors as process heat  
source 22 p0284 A79-26624
- Pellet X-ray spectra for laser fusion reactor  
designs 22 p0291 A79-27878
- Characteristics of  
electron-cyclotron-resonance-heated tokamak  
power reactors 22 p0292 A79-27885
- Design and development of the US-TESPE toroidal coil 22 p0311 A79-31014
- Thermoelectric magnetohydrodynamics 22 p0312 A79-31098
- Large tokamak experiments - Report on the Third  
IAEA Technical Committee Meeting, Paris, 1-6  
September 1978 22 p0313 A79-31193
- Overview of the magnetic fusion energy development  
and technology program [HCP/T3073-01] 21 p0193 N79-11887
- Civilian applications of laser fusion [UCRL-52349] 21 p0195 N79-12439
- REACTOR MATERIALS**
- Liquid metal heat pipe performance in the presence  
of a transverse magnetic field --- for fusion  
reactors [ASME PAPER 78-PN-20] 21 p0048 A79-12569
- REACTOR PHYSICS**
- The synergetics of the catalytic  
D-D-fusion-fission breeder 22 p0252 A79-22236
- Large tokamak experiments - Report on the Third  
IAEA Technical Committee Meeting, Paris, 1-6  
September 1978 22 p0313 A79-31193
- Gaseous fuel reactors for power systems [LA-UR-78-1437] 21 p0214 N79-13844
- REACTOR SAFETY**
- Energy and Technology Review, June 1978 ---  
composite materials for flywheels, shale oil  
recovery, and seismic safety at nuclear power  
plants [UCRL-52000-78-6] 21 p0215 N79-14168
- Environmental and radiological safety studies.  
Interaction of (Pu-238)O<sub>2</sub> heat sources with  
terrestrial and aquatic environments --- soil  
and water analysis [LA-7033-PR] 21 p0232 N79-15783
- REACTOR TECHNOLOGY**
- Heavy-ion beam inertial-confinement fusion 21 p0054 A79-13448
- Large tokamak experiments - Report on the Third  
IAEA Technical Committee Meeting, Paris, 1-6  
September 1978 22 p0313 A79-31193
- Stored energy calculation: The state of the art  
[PNL-2581] 21 p0210 N79-13541
- REAL TIME OPERATION**
- Real time computer control of 5 megawatts of solar  
thermal energy 21 p0144 A79-17621
- RECEIVERS**
- Receiver designs for tower-top solar collector 21 p0135 A79-17450
- Assessment of economic factors affecting the  
satellite power system. Volume 2: The systems  
implications of rectenna siting issues  
[NASA-CR-161186] 22 p0368 N79-21552
- RECIRCULATIVE FLUID FLOW**
- Mass transfer in a current source during  
circulation of the mixture driven by gaseous  
reaction products --- in fuel cell 21 p0164 A79-19851
- RECLAMATION**
- Solid waste and biomass. Their potential as  
energy sources in Illinois, 1977 [PB-281649/4] 21 p0177 N79-10562
- Remote monitoring of coal strip mine rehabilitation  
[PB-286647/3] 21 p0228 N79-15379
- RECOMBINATION COEFFICIENT**
- Spectral characteristics of photoconverters with  
nonuniform defect distribution in the base 21 p0053 A79-13289
- RECORDING INSTRUMENTS**
- Data acquisition using a modular data logger ---  
for solar heated building monitoring 21 p0088 A79-15832
- RECTIFIERS**
- Thyristor controlled rectifier inverting at unity  
power factor 21 p0033 A79-10898
- RECYCLING**
- The need for materials recycling 21 p0047 A79-12340
- Energy conservation by means of recycling 21 p0112 A79-16735
- Development of specifications for recycled products 22 p0295 A79-28182
- US Army/Environmental Projection Agency re-refined  
engine oil program [AD-A056806] 21 p0171 N79-10216
- Energy use patterns for metal recycling  
[PB-284855/4] 21 p0201 N79-13152
- REDUCTION (CHEMISTRY)**
- O<sub>2</sub> reduction kinetics in concentrated acids --- in  
fuel cells 21 p0038 A79-11809
- The direct reduction of sulfur dioxide 21 p0065 A79-14124
- Coal gasification studies. III - Reduction in the  
presence of some metal iodides and iron halides 22 p0299 A79-29314
- REFINING**
- Operation of the Ft. Lewis, Washington Solvent  
Refined Coal /SRC/ Pilot Plant in the SRC I and  
SRC II processing modes 21 p0006 A79-10054
- Chemicals from coal. Report based on BRI B-coal  
product [PB-1534-50] 21 p0180 N79-11166
- REFLECTANCE**
- Specular mirrors for solar energy application 21 p0034 A79-11147
- Ideal prism solar concentrators 21 p0149 A79-18023
- Colored stainless steel - A new type of selective  
absorber --- for solar thermal conversion 22 p0294 A79-28150
- Augmented solar energy collection using various  
planar reflective surfaces: Theoretical  
calculations and experimental results [LA-7041] 21 p0185 N79-11494
- REFLECTORS**
- Large, lightweight, replicated mirrors 21 p0043 A79-11976
- REFRACTION**
- Linear echelon refractor/reflector solar  
concentrators 22 p0293 A79-28143
- REFRACTIVITY**
- Review of theories for predicting n<sub>2</sub> in glasses  
and crystals --- refractive index of fusion  
laser materials 21 p0083 A79-15139

## REFRACTORY MATERIALS

## SUBJECT INDEX

## REFRACTORY MATERIALS

- Materials --- for high temperature MHD technology 21 p0106 A79-16491
- Ceramic materials for vehicular gas turbine applications 21 p0165 A79-20085
- MHD power generation: Research, development and engineering [FE-3087-2] 22 p0363 A79-20518
- REFRACTORY METALS**
- Growth of refractory oxide layers by electrochemical vapor deposition /EVD/ at elevated temperatures --- for fuel cells 21 p0039 A79-11812
- REFRIGERANTS**
- Solar absorption cooling 21 p0090 A79-15861
- Candidate chemical systems for air cooled, solar powered, absorption air conditioner design. Part 2: Solid absorbents, high latent heat refrigerants [SAN/1587-2] 21 p0211 A79-13544
- REFRIGERATING**
- Solar ammonia-water absorption system for cold storage application 21 p0143 A79-17521
- Cryogenic technology and superconductivity in controlled fusion 22 p0311 A79-31003
- Refrigeration requirements for future superconductive energy related applications 22 p0311 A79-31019
- REFRIGERATING MACHINERY**
- Optimising the pitching of tubes in a flat solar collector for increasing the efficiency for use in vapour absorption refrigeration 21 p0132 A79-17422
- Cryogenic refrigeration, volume 2. A bibliography with abstracts [NTIS/PS-78/1261/3] 22 p0331 A79-16144
- Cryogenic refrigeration, volume 3. A bibliography with abstracts [NTIS/PS-78/1262/1] 22 p0331 A79-16145
- REFRIGERATORS**
- Performance testing of a three ton solar absorption chiller [AIAA PAPER 78-1757] 21 p0060 A79-13858
- Design of a solar energy operated lithium-bromide water absorption refrigeration system for refrigeration storage 21 p0143 A79-17523
- Gas-cycle solar refrigeration system performance 21 p0153 A79-18471
- Design and optimisation of an absorption refrigeration system operated by solar energy 22 p0285 A79-26819
- REFUELING**
- Plasma density measurements on refuelling by solid hydrogen pellets in a rotating plasma 22 p0255 A79-22369
- Mechanically rechargeable, metal-air batteries for automotive propulsion [UCRL-81178] 21 p0189 A79-11538
- REGENERATION (ENGINEERING)**
- Simulations of the performance of open cycle desiccant systems using solar energy 21 p0066 A79-14262
- A regenerative process for fluidized-bed combustion of coal with lime additives 22 p0297 A79-28984
- Methane generation from human, animal, and agricultural wastes [PB-276469/4] 21 p0171 A79-10240
- Engineering and economic analysis of waste to energy systems [PB-285797/7] 21 p0224 A79-14946
- REGENERATIVE FUEL CELLS**
- The 100 kW space station --- regenerative fuel cells and nickel hydrogen and nickel cadmium batteries for solar arrays 22 p0371 A79-21603
- REGENERATORS**
- Reliability and durability of ceramic regenerators for gas turbine applications 21 p0050 A79-12823
- Rate of desorption in a solar regenerator 21 p0055 A79-13611

- Study of a heat exchanger with heat pipes within the system of a small-scale gas-turbine engine 21 p0114 A79-16800
- Buoyancy effects in a solar regenerator --- for air dehumidifier absorbent solutions 22 p0262 A79-23752

## REGIONAL PLANNING

- Prospects for ambient energy and cogeneration utilization in urban and regional planning 21 p0104 A79-16465
- Regional analysis of potential water power 21 p0148 A79-17825
- The economics of geothermal energy development at the regional level 22 p0256 A79-22756
- Structuring a small national or state solar energy program 22 p0262 A79-23751
- Solutions to energy conservation in northern climates 22 p0321 A79-31443
- Energy availabilities for state and local development: Projected energy patterns for 1980 and 1985 [ORNL/TN-5890/54] 21 p0186 A79-11511
- Urbanism and energy in developing regions [LBL-7808] 21 p0189 A79-11540
- Projects to expand energy sources in the western states [PB-283706/0] 21 p0190 A79-11547
- Energy supply and environmental impacts: Conventional sources, study module 3-A, technical appendix [PB-283787/0] 21 p0198 A79-12573
- Energy and environment: An intergovernmental perspective [PB-283733/4] 21 p0198 A79-12575
- Managing oil and gas activities in coastal environments [PB-283677/3] 21 p0199 A79-12576
- Energy future Northwest: Northwest Energy Policy project [PB-284697/0] 21 p0199 A79-12578
- Cooking with offshore oil: A handbook for California local government --- regional planning [PB-288656/2] 22 p0331 A79-16140
- Applying NASA remote sensing data to geologically related regional planning problems in Tennessee [E79-10095] 22 p0339 A79-17289

## REGULATIONS

- Proposed standby gasoline rationing plan. Economic and regulatory analysis draft [DOE/EBA-0009] 21 p0214 A79-13934
- Integrated safeguards information System (ISIS), executive summary --- nuclear power plant and fissionable materials security [PB-286869/3] 21 p0223 A79-14934
- Interagency coal cleaning technology development 22 p0347 A79-18361
- Solar building regulatory study, volume 2 [PB-289824/5] 22 p0357 A79-20291
- Solar building regulatory study, volume 1 [PB-289823/7] 22 p0365 A79-21235

## REINFORCED PLASTICS

- Large, lightweight, replicated mirrors 21 p0043 A79-11976

## RELATIVISTIC PARTICLES

- Radiation energy conversion in space 22 p0284 A79-26595

## RELAXATION (MECHANICS)

- NMR studies of hydrogen relaxation and diffusion in TiFeH/x/ and TiFe/1-y/Hn/y/H/x/ 22 p0248 A79-21684

## RELAXATION TIME

- Relaxation of a fast ion beam in a tokamak plasma 22 p0324 A79-31760

## RELIABILITY ANALYSIS

- User experience with on-road electric vehicles in the U.S.A. and Canada 21 p0009 A79-10080
- Nickel-zinc vs. silver-zinc battery - A comparative study of baseline characteristics 21 p0009 A79-10083
- Is there repair after failure --- reliability of repairable vs. nonrepairable engines 21 p0086 A79-15378
- A challenging role for the assurance sciences --- in energy conversion technology 21 p0086 A79-15396



# SUBJECT INDEX

# RESEARCH AND DEVELOPMENT

- Combined environments: Technology interrelations;  
Proceedings of the Twenty-fourth Annual  
Technical Meeting, Fort Worth, Tex., April  
18-20, 1978 21 p0097 A79-16076
- Reliability studies on HES solar cells 21 p0148 A79-17950
- Determining the reliability of radioisotope  
thermoelectric generators /RTGs/ designed for  
terrestrial and undersea applications 22 p0261 A79-23622
- Accelerated tests for coatings --- for solar  
concentrators 22 p0296 A79-28668
- The London Electric Delivery Van Assessment Scheme  
[SAE PAPER 790111] 22 p0314 A79-31358
- Report on a survey of operational solar systems 22 p0318 A79-31418
- Reliability of wind power from dispersed sites: A  
preliminary assessment 21 p0176 A79-10547
- Verification test report on a solar heating and  
hot water system [NASA-CR-161165] 22 p0360 A79-20493
- Evaluation of ceramics for stator application:  
Gas turbine engine report [NASA-CR-159533] 22 p0364 A79-21075
- RELIABILITY ENGINEERING**
- Design criteria for multilayer superconductive  
magnets 22 p0236 A79-20536
- Unique aspects of terrestrial photovoltaic system  
design [ASME PAPER 79-SOL-14] 22 p0308 A79-30548
- REMOTE HANDLING**
- The impact of servicing requirements on tokamak  
fusion reactor design 21 p0079 A79-14793
- Manned remote work station development article  
[NASA-CR-151871] 22 p0330 A79-16057
- REMOTE REGIONS**
- NASA Lewis Research Center photovoltaic  
application experiments [AIAA PAPER 78-1768] 21 p0061 A79-13867
- An overview of photovoltaic power systems  
[ASME PAPER 79-SOL-12] 22 p0308 A79-30547
- REMOTE SENSORS**
- Instrumentation development for in situ coal  
gasification 21 p0006 A79-10053
- Joint Conference on Sensing of Environmental  
Pollutants, 4th, New Orleans, La., November  
6-11, 1977, Proceedings 21 p0082 A79-15023
- Future programs and prospects for resource  
exploration from space by the year 2000  
[AAS PAPER 78-182] 22 p0243 A79-21275
- Energy and remote sensing applications 22 p0255 A79-22516
- Remote sensing use in hydraulic planification in  
Mexico 22 p0255 A79-22522
- Infrared remote sensing on geothermal areas by  
helicopter 22 p0256 A79-22620
- Remote sensing and mine subsidence in Pennsylvania  
22 p0303 A79-29936
- Instrumentation for in situ coal gasification. IV  
- Seismic and acoustic techniques for remote  
monitoring 22 p0304 A79-29974
- Application of multispectral scanner data to the  
study of an abandoned surface coal mine  
[NASA-TM-78912] 21 p0204 A79-13472
- Remote monitoring of coal strip mine rehabilitation  
[PB-286647/3] 21 p0228 A79-15379
- REMOTELY PILOTED VEHICLES**
- Nickel-zinc battery for aircraft and missile  
applications [AD-A059295] 21 p0220 A79-14561
- REPLENISHMENT**
- Need for and deployment of inexhaustible energy  
resource technologies: Report of Technology  
Study Panel inexhaustible energy resources study  
[TID-28202] 21 p0186 A79-11510
- REPORTS**
- LSA Low-cost Solar Array project  
[NASA-CR-158250] 22 p0355 A79-19462
- MHD power generation: Research, development and  
engineering [PB-2524-8] 22 p0363 A79-20517
- RESEARCH**
- Strategies for applied research management  
[PB-284741/6] 21 p0214 A79-13913
- Hydrogen technology from thermonuclear research 22 p0338 A79-16997
- NACA research on hydrogen for high altitude aircraft 22 p0338 A79-16999
- MHD power generation: Research, development and  
engineering [PB-3087-2] 22 p0363 A79-20518
- RESEARCH AND DEVELOPMENT**
- Intersociety Energy Conversion Engineering  
Conference, 13th, San Diego, Calif., August  
20-25, 1978, Proceedings. Volumes 1, 2 & 3 21 p0001 A79-10001
- Oil recovery from a Utah tar sand deposit by in  
situ combustion 21 p0004 A79-10043
- Exxon Donor Solvent coal liquefaction process  
development 21 p0007 A79-10060
- Exploratory research in coal conversion 21 p0007 A79-10061
- JPL - Small Power Systems Applications Project ---  
for solar thermal power plant development and  
commercialization 21 p0019 A79-10161
- Evaluation program for new industrial gas turbine  
materials [ASME PAPER 78-GT-145] 21 p0031 A79-10269
- ERDA fuel cell programs 21 p0039 A79-11814
- Summary of international energy research and  
development activities 1974-1976 --- Book 21 p0068 A79-14400
- Predemonstration fusion devices - Research and  
development needs 21 p0078 A79-14785
- Biomimetic approach to solar energy conversion -  
Artificial photosynthesis 21 p0094 A79-15899
- Westinghouse fluidized bed coal gasification  
system - Experience and plans 21 p0096 A79-15924
- The solar energy R & D programme of the European  
Communities 21 p0116 A79-17278
- Solar energy in Latin America - An overview 21 p0116 A79-17279
- Report on the development of solar energy in France 21 p0117 A79-17280
- The accomplishments of the United States Federal  
Solar Energy Program 21 p0117 A79-17281
- Solar energy research, development and  
demonstration program in Kuwait 21 p0117 A79-17282
- Solar energy activities in Austria 21 p0117 A79-17283
- Solar energy R&D in Iran - The approach and the  
philosophy 21 p0117 A79-17284
- Plans and prospects for solar energy utilisation  
in Malawi 21 p0117 A79-17285
- Solar energy in Southern Africa 21 p0117 A79-17287
- Fracture research in Canada 21 p0144 A79-17530
- Coal technology '78; International Coal  
Utilization Convention, Houston, Tex., October  
17-19, 1978, Conference Papers. Volumes 1 & 2 21 p0145 A79-17631
- A summary of R&D programs --- for coal utilization 21 p0146 A79-17639
- General view of low cost solar cell development in  
Japan 21 p0149 A79-17997
- Transport fuels from natural gas 22 p0292 A79-27897
- Lignite - Abundant raw material of the future 22 p0296 A79-28438
- Recent developments in power sources with special  
emphasis on alkaline batteries --- for electric  
vehicles 22 p0301 A79-29490

## RESEARCH FACILITIES

Developing electric vehicles 22 p0302 A79-29496

Latest developments in sponsored test programs for electric vehicles in France 22 p0302 A79-29497

NERC's wind energy program 22 p0319 A79-31426

Energy and aerospace; Proceedings of the Anglo/American Conference, London, England, December 5-7, 1978 22 p0325 A79-31908

The Energy Research and Development Program of the United States 22 p0325 A79-31909

Energy research and development - A U.K. view 22 p0325 A79-31910

Electric batteries. A bibliography [TID-3361] 21 p0184 N79-11491

Annual highlights of the energy technology programs [BNL-50799] 21 p0185 N79-11499

Coal research: Data systems and information transfer [ORAU-133] 21 p0232 N79-15830

Electric and Hybrid Vehicle Act, Public Law 94-413 demonstration program objective and schedule [CPO-98-809] 22 p0351 N79-18810

Critical contributions in MHD power generation [PE-2215-11] 22 p0362 N79-20511

MHD power generation: Research, development and engineering [PE-2524-8] 22 p0363 N79-20517

**RESEARCH FACILITIES**

The mirror machine program in the USA --- controlled fusion experiments and research facilities 21 p0070 A79-14461

Effort of the Jet Propulsion Laboratory 22 p0370 N79-21575

Levis Research Center program 22 p0370 N79-21576

**RESEARCH MANAGEMENT**

Potential research problems in energy systems 21 p0115 A79-17221

Some perspectives on research into the biological response to non-ionizing electromagnetic radiation --- relation to SETI, SPS, and other government projects 22 p0271 A79-24879

Energy policy and research planning, volume 2. A bibliography with abstracts [NTIS/PS-78/0961/9] 21 p0191 N79-11552

Energy policy and research planning, volume 3. A bibliography with abstracts [NTIS/PS-78/0962/7] 21 p0191 N79-11553

Strategies for applied research management [PB-284741/6] 21 p0214 N79-13913

General aviation energy-conservation research programs 22 p0329 N79-15963

Public hearing transcript: Federal non-nuclear energy research and development program [PB-287910/4] 22 p0349 N79-18464

**RESEARCH PROJECTS**

Underground coal gasification research at the University of New Mexico 21 p0032 A79-10523

Summary of international energy research and development activities 1974-1976 --- Book 21 p0068 A79-14400

Fusion power by magnetic confinement - Program plan 21 p0080 A79-14794

Solar heating and cooling. Research and development: Project summaries [DOE/CS-0010] 21 p0208 N79-13519

FY 1978 scientific and technical reports, articles, papers, and presentations --- bibliography [NASA-TM-78203] 21 p0214 N79-13915

**RESERVOIRS**

Optimal decisions for long-term operation of hydropower systems 22 p0245 A79-21473

A fundamental model for the evolution of a two-phase geothermal reservoir with application to environmental impact analysis 22 p0263 A79-23777

## SUBJECT INDEX

Thermal stress cracking and the enhancement of heat extraction from fractured geothermal reservoirs [LA-7235-MS] 21 p0198 N79-12568

Research on the physical properties of geothermal reservoir rock [COO-2908-4] 22 p0358 N79-20459

**RESIDENTIAL AREAS**

Residential energy design 21 p0073 A79-14694

Fuel cell on-site integrated energy system parametric analysis of a residential complex 21 p0081 A79-14947

Conceptual development of a solar town in Iran 21 p0138 A79-17469

Solar photovoltaic power for residential use [ASHE PAPER 79-SOL-11] 22 p0308 A79-30546

Passive solar heating - Results from two Saskatchewan residences 22 p0322 A79-31444

Solar heating and cooling demonstration project summaries [DOE/CS-0009] 21 p0186 N79-11503

Solar space heaters for low-income families [PB-289244/6] 22 p0363 N79-20526

Interim performance criteria for solar heating and cooling systems in residential buildings, second edition [PB-289967/2] 22 p0372 N79-21630

**RESIDUES**

Gasification of coal liquefaction residues 21 p0006 A79-10059

Combustion rates for oil shale carbonaceous residue 21 p0032 A79-10522

Preliminary environmental assessment of energy conversion processes for agricultural and forest product residues, volume 1 [PB-281189/1] 21 p0178 N79-10574

Environmental assessment of solid residues from fluidized-bed fuel processing [PB-282940/6] 21 p0179 N79-10968

Catalyst evaluation for denitrogenation of petroleum residua and coal liquids, phase 5 [PB-287180/4] 22 p0339 N79-17026

**RESISTANCE HEATING**

Ohmic heating experiments in the W VII A stellarator 21 p0069 A79-14458

Ohmic heating experiments in the L-2 stellarator 21 p0070 A79-14460

Review of experimental results. I, II --- MHD instability effects on tokamak confinement with ohmic heating 21 p0077 A79-14778

Heattube, a universal electrical solar heat equipment for building, community and agricultural purposes 21 p0138 A79-17473

Properties of the plasma ions and the particle lifetime in ohmic heating in the L-2 stellarator 22 p0244 A79-21428

Empirical scaling laws for energy confinement in ohmically-heated tokamaks 22 p0253 A79-22240

**RESOURCE ALLOCATION**

Economics and net energy analysis - Is a new analytical technique needed for energy decision making 21 p0074 A79-14706

Industrial international data base: Energy analysis methodology. Rational use of energy program pilot study [NATO/CCMS-75] 21 p0206 N79-13508

Proposed standby gasoline rationing plan. Economic and regulatory analysis draft [DOE/EPA-0009] 21 p0214 N79-13934

Energy information: Report to Congress [NTISUB/C/027-001] 21 p0221 N79-14576

The impact of energy resource development on water resource allocations [PB-286135/9] 21 p0231 N79-15432

**RESOURCE MANAGEMENT**

Current and potential uses of aerospace technology by the U.S. Department of the Interior [AIAA PAPER 78-1716] 21 p0060 A79-13833

Quantification of energy resource consumption 21 p0073 A79-14791

Time, technology and capital - Do we have enough to solve the energy crisis 21 p0097 A79-16100

# SUBJECT INDEX

# ROTATING PLASMAS

Remote sensing use in hydraulic planification in Mexico 22 p0255 A79-22522

Weak points of our prediction models for raw materials strategy --- waste materials and scrap recycling 22 p0265 A79-24040

The energy and resource implications associated with the widespread use of electric vehicles 22 p0301 A79-29489

Energy needs, uses, and resources in developing countries [BNL-50784] 21 p0185 A79-11500

Analytical framework for the assessment of energy resource and technology options for developing countries [BNL-50800] 21 p0208 A79-13524

The national energy plan: Options under assumptions of national security threat --- economic impact procurement policy, and resources management [H-PRINT-95-48] 21 p0228 A79-15398

The effects of resource impact factors on energy conservation standards for buildings [PB-286909/7] 22 p0335 A79-16384

Technology assessment of western energy resource development 22 p0347 A79-18368

Baltimore applications project [NASA-TN-79667] 22 p0351 A79-18815

**RETROFITTING**

A solar energy system for space heating and space cooling --- retrofitting aged buildings 21 p0072 A79-14686

Solar retrofitting of existing residence with almost zero delta TE system 21 p0139 A79-17485

The performance of a site built, air heating, vertical collector with snow reflector in Quebec 22 p0319 A79-31423

Solar energy retrofit system for an older-type building - The Williamstown Museum project 22 p0320 A79-31434

Determination of the potential for solar retrofitting in Edmonton --- pilot systems for single family dwellings 22 p0323 A79-31456

**RETROREFLECTION**

Large active retrodirective arrays for solar power satellites 21 p0107 A79-16604

**RHODESIA**

Description of hydro-electric development and proposal for future development on the Zambezi 22 p0340 A79-17323

**RIGID ROTORS**

The Netherlands experimental vertical axis wind turbine 21 p0114 A79-17120

**RIGID STRUCTURES**

The improved rigid airship --- design characteristics and cost analysis 21 p0086 A79-15572

**RING STRUCTURES**

On vibration of a thick flexible ring rotating at high speed --- for flywheel energy storage 22 p0235 A79-20511

Flux-redistribution in the focal region of a planar Fresnel ring mirror --- solar furnace design 22 p0263 A79-23764

**RISK**

Risk control in the development of energy processes --- environment, worker and capital considerations in coal gasification 21 p0085 A79-15372

Risk with energy from conventional and nonconventional sources 22 p0266 A79-24151

**RIVER BASINS**

A commentary on a methodology for assessment of the environmental impact of the electrical power system within the Connecticut River Basin 21 p0093 A79-15893

**RIVERS**

Description of hydro-electric development and proposal for future development on the Zambezi 22 p0340 A79-17323

**ROCKS**

Hot dry rock - A new geothermal energy source 21 p0087 A79-15673

Hot dry rock, an abundant clean energy resource 21 p0098 A79-16106

Long-term storage of solar energy in native rock 21 p0120 A79-17314

A passive rock bed - Design, construction, and performance 21 p0121 A79-17328

Hot dry rock - A new potential for energy 22 p0265 A79-23832

Thermal conductivity of crystalline rocks associated with energy extraction for hot dry rock geothermal systems 22 p0304 A79-30123

Studies on the effect of bed aspect ratios and pressure drop on flow distribution in rock bed storage systems for solar energy applications 22 p0317 A79-31409

Sensible heat storage for solar energy applications 22 p0322 A79-31449

Alternate energy installations on the Jordan College Campus 22 p0323 A79-31454

Hot dry rock energy project [LA-UR-77-2744] 21 p0175 A79-10540

Late diagenetic indicators of buried oil and gas. 2: Direct detection experiment at Cement and Garza fields, Oklahoma and Texas, using enhanced LANDSAT 1 and 2 images [E79-10099] 22 p0347 A79-18373

Research on the physical properties of geothermal reservoir rock [COO-2908-4] 22 p0358 A79-20459

**ROOM TEMPERATURE**

New alloy systems for hydrogen storage 21 p0038 A79-11806

**ROTARY STABILITY**

Rotating strength of glass-carbon fiber-reinforced hybrid composite discs 21 p0165 A79-20273

**ROTARY WINGS**

Lag damping in autorotation by a perturbation method --- for rigid rotor blades [AHS 78-25] 21 p0152 A79-218151

Aeroelastic response and stability of a coupled rotor/support system with application to large horizontal axis with turbines 22 p0332 A79-16346

**ROTATING BODIES**

On vibration of a thick flexible ring rotating at high speed --- for flywheel energy storage 22 p0235 A79-20511

Rotatable mass for a flywheel [NASA-CASE-MPS-23051-1] 21 p0172 A79-10422

Demonstration of a rotary separator for two-phase brine and steam flows [TID-28519] 22 p0365 A79-21309

**ROTATING CYLINDERS**

The Madaras Rotor Power Plant - An alternate method for extracting large amounts of power from the wind [AIAA PAPER 79-0115] 21 p0157 A79-19541

**ROTATING DISKS**

Rotating strength of glass-carbon fiber-reinforced hybrid composite discs 21 p0165 A79-20273

**ROTATING FLUIDS**

On the diffusive instability of some simple steady magnetohydrodynamic flows 22 p0278 A79-26163

**ROTATING PLASMAS**

A collisional plasma rotating between two cylinders 21 p0049 A79-12694

Investigation of the Hall effect in a discharge with a rotational electric field 22 p0246 A79-21532

Measurements of plasma rotation in tokamak LT-3 22 p0252 A79-22238

Plasma density measurements on refuelling by solid hydrogen pellets in a rotating plasma 22 p0255 A79-22369

Theory of the striated corona in a theta pinch 22 p0295 A79-28315

## ROTATING SHAFTS

### ROTATING SHAFTS

- A simple solar tracking system --- manually adjusted rotating shaft for solar concentrator positioning 21 p0136 A79-17457

### ROTOR AERODYNAMICS

- Airfoil data for use of wind turbine designers 21 p0073 A79-14702
- A two dimensional vortex sheet model of a Savonius Rotor 22 p0278 A79-26178
- Design, instrumentation, and calibration of a vertical axis wind turbine rotor [TID-27754] 21 p0174 A79-10533

### ROTOR BLADES

- A small horizontal axis wind turbine feeding power into the utility grid 21 p0074 A79-14703
- High efficiency wave engine --- featuring rotor blade exit nozzle design for high efficiency 22 p0279 A79-26187

### ROTOR BLADES (TURBOMACHINERY)

- Airfoil data for use of wind turbine designers 21 p0073 A79-14702
- Wind-turbine-generator rotor-blade concepts with low-cost potential 22 p0240 A79-20828
- An operating 200 kW horizontal axis wind turbine 22 p0240 A79-20829
- Design, fabrication, and test of a composite material wind turbine rotor blade [NASA-CR-135389] 21 p0173 A79-10525
- Evaluation of urethane for feasibility of use in wind turbine blade design [NASA-CR-159530] 22 p0360 A79-20497

### ROTOR SPEED

- A small horizontal axis wind turbine feeding power into the utility grid 21 p0074 A79-14703
- Air bearing development for a GM automotive gas turbine 22 p0314 A79-31355

### ROTOR

- Toroidal Accelerator Rotor Platforms for wind energy conversion 21 p0029 A79-10240
- Test and development of ceramic combustors, stators, nose cones, and rotor tip shrouds 21 p0049 A79-12821
- Preliminary design of a subscale ceramic helical-rotor expander 21 p0050 A79-12849

- Giromill wind tunnel test and analysis, volume 2. Technical discussion [CDO-2617-4/2] 21 p0204 A79-13378

### RURAL AREAS

- On the depletion of ambient ozone by a rural coal-fired power plant near Portage, Wisconsin 21 p0082 A79-15052
- Solar electrification and rural electrification - A techno-economic review 21 p0118 A79-17289
- Bio-mass energy for rural areas 21 p0126 A79-17373
- Development of small solar power plants for rural areas in India 21 p0141 A79-17502
- A methodology for evaluating the worth of a new energy resource with particular reference to wind energy utilisation in rural areas 21 p0143 A79-17514
- Photovoltaic power systems for rural areas of developing countries 22 p0278 A79-26131
- An overview of photovoltaic power systems [ASME PAPER 79-SOL-12] 22 p0308 A79-30547
- Photovoltaic power systems for rural areas of developing countries [NASA-TN-79097] 21 p0229 A79-15411
- Energy conservation and the rural home: Economic considerations for the nation and the individual [PB-286222/5] 21 p0230 A79-15425

## S

### SAFETY FACTORS

- Problems, status, and prospects of a solar hydrogen economy 21 p0059 A79-13658

## SUBJECT INDEX

- Radially resolved measurements of 'q' on the adiabatic toroidal compressor tokamak --- safety factor 21 p0155 A79-18830

- Some environmental and safety aspects of using hydrogen as a fuel 22 p0238 A79-20774

### SAFETY MANAGEMENT

- Solar heating and safety techniques 21 p0056 A79-13633
- Safety requirements for solar heating systems - Practical considerations 21 p0056 A79-13634
- Risk control in the development of energy processes --- environment, worker and capital considerations in coal gasification 21 p0085 A79-15372
- Liquefied natural gas safety research overview [AD-A063714] 22 p0365 A79-21233

### SAIIS

- The design and testing of a vertical-axis wind turbine using sails 21 p0153 A79-18467
- Sail power for the world's cargo ships 22 p0305 A79-30374

### SALINITY

- Geothermal power from salt domes 21 p0014 A79-10120
- Assessment of the potential of generating power from aqueous saline solutions by means of Osmo-Hydro Power systems 21 p0016 A79-10133
- Solar pond stability experiments 21 p0042 A79-11878
- Salinity power station at the Swedish west-coast - Possibilities and energy-price for a 200 MW-plant 21 p0077 A79-14772

### SAHARIUM COMPOUNDS

- Development of a satellite flywheel family operating on one active axis magnetic bearings 22 p0366 A79-21392

### SAMPLERS

- Measurement of high-temperature, high-pressure processes [PB-284041/1] 21 p0195 A79-12424

### SAMPLING

- Sampling and analysis of synthetic fuel processes --- coal gasification and liquefaction effluent analysis 22 p0284 A79-26538

### SANDS

- High temperature thermal energy storage in moving sand 21 p0012 A79-10103

### SATELLITE ANTENNAS

- Advanced composites - Future space applications 21 p0086 A79-15504
- Large active retrodirective arrays for solar power satellites 21 p0107 A79-16604
- Space will be the next big construction site 22 p0268 A79-24450

### SATELLITE ATTITUDE CONTROL

- Transient attitude dynamics of satellites with deploying flexible appendages 21 p0047 A79-12325
- Attitude and pointing control system for the microwave antenna of the solar power satellite 21 p0113 A79-16739

### SATELLITE DESIGN

- Intelsat V solar array design and development summary 21 p0002 A79-10018
- Structures for solar power satellites 21 p0032 A79-10513
- Solar power satellites revisited 21 p0093 A79-15898
- Design considerations for solar power satellites 21 p0113 A79-16738
- An evolutionary solar power satellite program [AAS PAPER 78-153] 22 p0243 A79-21265
- Satellite Power Systems (SPS) concept definition study (exhibit C) [NASA-CR-150827] 21 p0183 A79-11475
- Solar power satellite rectenna design study: Directional receiving elements and parallel-series combining analysis [NASA-CR-151866] 22 p0330 A79-16039

# SUBJECT INDEX

# SATELLITE SOLAR ENERGY CONVERSION

## SATELLITE OBSERVATION

Current and potential uses of aerospace technology by the U.S. Department of the Interior [AIAA PAPER 78-1716] 21 p0060 A79-13833  
Use of satellites in solar applications --- for insolation mapping and space power stations 21 p0104 A79-16468  
Landsat - Developing techniques and applications in mineral and petroleum exploration 21 p0111 A79-16725  
Future programs and prospects for resource exploration from space by the year 2000 [AAS PAPER 78-182] 22 p0243 A79-21275

## SATELLITE ORIENTATION

A problem of optimizing the setting angle of sun-battery panels of concave shape --- onboard satellite 21 p0045 A79-12186

## SATELLITE POWER TRANSMISSION (TO EARTH)

Satellite power systems /SPS/ overview 21 p0002 A79-10022  
A microwave power transmission system for space satellite power 21 p0002 A79-10025  
Power distribution study for a 5-GW space power satellite 21 p0002 A79-10026  
From sunlight in space to 60 Hz on earth - The losses along the way --- satellite solar power transmission efficiency 21 p0003 A79-10027  
Environmental considerations for the microwave beam from a solar power satellite 21 p0003 A79-10030  
A 5-GWe nuclear satellite power system conceptual design 21 p0003 A79-10033  
Solar power satellite developments [AAS PAPER 78-022] 21 p0035 A79-11558  
An aperture-augmented prototype power satellite 21 p0046 A79-12268  
Radiation energy conversion in space; Conference, 3rd, NASA Ames Research Center, Moffett Field, Calif., January 26-28, 1978, Technical Papers 21 p0107 A79-16601  
SPS microwave subsystem potential impacts and benefits --- environmental and societal effects of Solar Power System construction and operation 21 p0107 A79-16603  
Large active retrodirective arrays for solar power satellites 21 p0107 A79-16604  
Application of electron beams in space for energy storage and optical beam generation 21 p0108 A79-16606  
Laser aircraft propulsion 21 p0109 A79-16618  
Laser-powered aircraft and rocket systems with laser energy relay units 21 p0109 A79-16619  
The use of lasers for the transmission of power 21 p0109 A79-16621  
New candidate lasers for power beaming and discussion of their applications --- solar powered space lasers 21 p0110 A79-16622  
Status and summary of laser energy conversion --- for space power transmission systems 21 p0111 A79-16635  
Design considerations for solar power satellites 21 p0113 A79-16738  
Financial/management scenarios for a satellite power system program [AAS PAPER 78-144] 22 p0243 A79-21259  
A development strategy for the solar power satellite [AAS PAPER 78-154] 22 p0243 A79-21266  
Power from space by laser 22 p0284 A79-26596  
Solar power satellite 22 p0287 A79-27375  
Status of the SPS concept development and evaluation program --- Solar Power Satellite 22 p0326 A79-31919  
Solar Power Satellite systems definition 22 p0326 A79-31920  
A review of some critical aspects of satellite power systems 22 p0326 A79-31921

Preliminary assessment of the environmental impacts of the Satellite Power System /SPS/ 22 p0326 A79-31922  
Satellite Power System (SPS) environmental impacts, preliminary assessment [NASA-CR-157952] 21 p0196 A79-12557  
Satellite Power System (SPS) microwave subsystem impacts and benefits [NASA-CR-157951] 21 p0196 A79-12558  
Microwave power transmitting phased array antenna research project [NASA-CR-157843] 21 p0202 A79-13263  
Accuracy analysis of pointing control system of solar power station [NASA-CR-150880] 21 p0215 A79-14143  
Satellite power systems (SPS) concept definition study. Volume 7: SPS program plan and economic analysis, appendixes [NASA-CR-150702] 21 p0225 A79-15142  
Satellite power systems (SPS) concept definition study. Volume 1: Executive summary [NASA-CR-150700] 22 p0329 A79-16036  
Satellite Power System (SPS) program summary [DOE/EE-0022] 22 p0337 A79-16893  
Satellite Power System (SPS) military applications [NASA-CR-158109] 22 p0337 A79-16895  
Solar Power Satellite (SPS) pilot beam and communication link subsystem investigation study, phase 1 --- ionospheric propagation, radio frequency interference, and microwave transmission [NASA-CR-161161] 22 p0345 A79-17896  
Satellite Power System (SPS) concept definition study (exhibit C) [NASA-CR-161173] 22 p0352 A79-19071  
Satellite power system: Concept development and evaluation program, reference system report [NASA-TN-80413] 22 p0367 A79-21538  
Assessment of economic factors affecting the satellite power system. Volume 1: System cost factors [NASA-CR-161185] 22 p0368 A79-21551  
Assessment of economic factors affecting the satellite power system. Volume 2: The systems implications of rectenna siting issues [NASA-CR-161186] 22 p0368 A79-21552

## SATELLITE SOLAR ENERGY CONVERSION

Orbiting Solar Observatory /OSO-8/ solar panel design and in-orbit performance 21 p0001 A79-10017  
The application of solar thermoelectric generators in near-sun missions 21 p0023 A79-10187  
Structures for solar power satellites 21 p0032 A79-10513  
A problem of optimizing the setting angle of sun-battery panels of concave shape --- onboard satellite 21 p0045 A79-12186  
Technology and development requirements of the solar power satellite 21 p0046 A79-12267  
Determining optimal angles of nonconvex solar battery panel mounting 21 p0080 A79-14837  
A search for space energy alternatives 21 p0108 A79-16608  
Ultralightweight structures for space power --- solar energy collection for transmission to earth 21 p0108 A79-16609  
Systems efficiency and specific mass estimates for direct and indirect solar-pumped closed-cycle high-energy lasers in space 21 p0110 A79-16623  
Radiation energy conversion in space 22 p0284 A79-26595  
Solar power satellites - The laser option 22 p0284 A79-26599  
Dynamics of stepping of the Hermes flexible solar array 22 p0323 A79-31615  
Solar cell workshop 21 p0170 A79-10141  
Solar array workshop 21 p0170 A79-10142  
Satellite Power System (SPS) concept definition study (exhibit C) [NASA-CR-150733] 21 p0225 A79-15137

- Satellite Power Systems (SPS) concept definition study. Volume 3: SPS concept evolution [NASA-CR-158066] 21 p0225 N79-15138
- Satellite Power Systems (SPS) concept definition study. Volume 6: SPS technology requirements and verification [NASA-CR-150685] 21 p0225 N79-15140
- Satellite Power Systems (SPS) concept definition study. Volume 7: SPS program plan and economic analysis [NASA-CR-158068] 21 p0225 N79-15141
- Satellite power systems (SPS) concept definition study. Volume 1: Executive summary [NASA-CR-150700] 22 p0329 N79-16036
- Satellite Power Systems (SPS) concept definition study. Volume 2: SPS system requirements [NASA-CR-150681] 22 p0330 N79-16037
- SATELLITE SOLAR POWER STATIONS**
- Satellite power systems /SPS/ overview 21 p0002 A79-10022
- Evolution of satellite power system /SPS/ concepts 21 p0002 A79-10023
- The design and evaluation of a 5 GW GaAlAs solar power satellite /SPS/ 21 p0002 A79-10024
- A microwave power transmission system for space satellite power 21 p0002 A79-10025
- Power distribution study for a 5-GW space power satellite 21 p0002 A79-10026
- From sunlight in space to 60 Hz on earth - The losses along the way --- satellite solar power transmission efficiency 21 p0003 A79-10027
- Solar Power Satellite thermal analysis 21 p0003 A79-10028
- Construction of a 10GWe solar power satellite 21 p0003 A79-10029
- Environmental considerations for the microwave beam from a solar power satellite 21 p0003 A79-10030
- Microwave phased array design considerations for SPS --- Solar Powered Satellites 21 p0003 A79-10031
- Development and testing of the ULP solar array 21 p0029 A79-10245
- Structures for solar power satellites 21 p0032 A79-10513
- Evolution of space power systems [IAF PAPER 78-43] 21 p0035 A79-11218
- The utilization of European space techniques for energy production [IAF PAPER 78-190] 21 p0035 A79-11287
- Solar energy and the 'Common Heritage of Mankind' --- international agreements regarding usage [IAF PAPER 78-SL-45] 21 p0035 A79-11356
- Solar power satellite developments [AAS PAPER 78-022] 21 p0035 A79-11558
- Technology and development requirements of the solar power satellite 21 p0046 A79-12267
- An aperture-augmented prototype power satellite 21 p0046 A79-12268
- Output power variations with solar power satellites 21 p0067 A79-14267
- Solar power satellites revisited 21 p0093 A79-15898
- Future space transportation systems 21 p0100 A79-16146
- Use of satellites in solar applications --- for insolation mapping and space power stations 21 p0104 A79-16468
- Radiation energy conversion in space; Conference, 3rd, NASA Ames Research Center, Moffett Field, Calif., January 26-28, 1978, Technical Papers 21 p0107 A79-16601
- The solar power satellite concept evaluation program 21 p0107 A79-16602
- SPS microwave subsystem potential impacts and benefits --- environmental and societal effects of Solar Power System construction and operation 21 p0107 A79-16603
- MHD conversion of solar energy --- space electric power system 21 p0109 A79-16614
- Theraionics and its application to the SPS --- solar power satellite for energy conversion 21 p0109 A79-16616
- Magnetically confined plasma solar collector --- satellite based system in space 21 p0109 A79-16617
- The use of lasers for the transmission of power 21 p0109 A79-16621
- New candidate lasers for power beaming and discussion of their applications --- solar powered space lasers 21 p0110 A79-16622
- Design considerations for solar power satellites 21 p0113 A79-16738
- Attitude and pointing control system for the microwave antenna of the solar power satellite 21 p0113 A79-16739
- Solar power satellites - An AIAA position paper 21 p0148 A79-17872
- Financial/management scenarios for a satellite power system program [AAS PAPER 78-144] 22 p0243 A79-21259
- An evolutionary solar power satellite program [AAS PAPER 78-153] 22 p0243 A79-21265
- A development strategy for the solar power satellite [AAS PAPER 78-154] 22 p0243 A79-21266
- Costing the satellite power system [AAS PAPER 78-166] 22 p0243 A79-21270
- Health maintenance and health surveillance considerations for an SPS space construction base community [AAS PAPER 78-176] 22 p0243 A79-21273
- Reversible thermoelectric power conversion of energy fluctuations 22 p0261 A79-23619
- Space will be the next big construction site 22 p0268 A79-24450
- Energy for Europe from space 22 p0273 A79-25605
- Space reflector technology and its system implications [AIAA PAPER 79-0545] 22 p0273 A79-25852
- The solar power satellite concept - The past decade and the next decade [AIAA PAPER 79-0534] 22 p0273 A79-25854
- Solar power satellite 22 p0287 A79-27375
- Space solar power - An energy alternative 22 p0303 A79-29796
- Solar energy via satellites and international cooperation 22 p0310 A79-30952
- Status of the SPS concept development and evaluation program --- Solar Power Satellite 22 p0326 A79-31919
- Solar Power Satellite systems definition 22 p0326 A79-31920
- A review of some critical aspects of satellite power systems 22 p0326 A79-31921
- Preliminary assessment of the environmental impacts of the Satellite Power System /SPS/ 22 p0326 A79-31922
- European aspects of Solar Satellite Power systems 22 p0326 A79-31923
- The Solar Power Satellite concept - Towards the future 22 p0327 A79-31925
- Satellite Power Systems (SPS) concept definition study (exhibit C) [NASA-CR-150827] 21 p0183 A79-11475
- Automatic phase control in solar power satellite systems [NASA-CR-151856] 21 p0194 A79-12130
- Statement of Doctor Klaus Heiss, President, ECHS, Incorporated, Princeton, New Jersey 21 p0224 A79-15110
- Satellite Power System (SPS) concept definition study (exhibit C) [NASA-CR-150733] 21 p0225 A79-15137
- Satellite Power Systems (SPS) concept definition study. Volume 3: SPS concept evolution [NASA-CR-158066] 21 p0225 A79-15138
- Satellite Power Systems (SPS) concept definition study. Volume 5: Transportation and operations analysis --- heavy lift launch and orbit transfer vehicles for orbital assembly [NASA-CR-158067] 21 p0225 A79-15139
- Satellite Power Systems (SPS) concept definition study. Volume 6: SPS technology requirements and verification [NASA-CR-150685] 21 p0225 A79-15140

## SUBJECT INDEX

## SELENIDES

- Microwave systems analysis, solar power satellite  
--- alignment of the antenna array  
[NASA-CR-160091] 22 p0337 N79-16892
- SATELLITES**  
Achievable flatness in a large microwave power  
antenna study  
[NASA-CR-151831] 21 p0171 N79-10272
- SAUDI ARABIA**  
Saudi Arabia looks at the sun 21 p0063 A79-13900
- SCALE (CORROSION)**  
Hot corrosion of Ni-base turbine alloys in  
atmospheres in coal-conversion systems 22 p0288 A79-27395
- SCALING LAWS**  
Empirical scaling laws for energy confinement in  
ohmically-heated tokamaks 22 p0253 A79-22240
- SCHOOLS**  
Application of solar cooling for a school building  
in subtropics 21 p0103 A79-16461
- SCHOTTKY DIODES**  
Interface properties and stability of Schottky  
barriers and MIS solar cells 21 p0123 A79-17342  
Sensitivity calculations for the design of solar  
cells. I - Schottky barrier devices 21 p0125 A79-17360  
Grain-boundary edge passivation of GaAs films by  
selective anodization --- shorting effect in  
solar cells 21 p0154 A79-18487  
Explanation for low-efficiency Cu2O  
Schottky-barrier solar cells 22 p0256 A79-22859  
The interfacial layer in MIS amorphous silicon  
solar cells 22 p0258 A79-23039  
The short-wavelength response of MIS solar cells 22 p0273 A79-25748  
Diffusion length measurements in Schottky barrier  
GaAs solar cells 22 p0281 A79-26243  
Measuring the quasi-Fermi level and flat band  
potential of an illuminated Au/n-GaAs/.6/P/.4/  
anode --- for solar cells 22 p0317 A79-31411  
Photovoltaic properties of metal-free  
phthalocyanines - Al/H2Pc Schottky barrier solar  
cells 22 p0317 A79-31412  
Solar cells having integral collector grids  
[NASA-CASE-LEW-12819-1] 21 p0182 N79-11467  
Silicon Schottky photovoltaic diodes for solar  
energy conversion [PB-283998/3] 21 p0198 N79-12572  
Back wall solar cell [NASA-CASE-LEW-12236-2] 21 p0217 N79-14528  
Silicon Schottky photovoltaic diodes for solar  
energy conversion [PB-287417/0] 22 p0343 N79-17349
- SCRAP**  
Weak points of our prediction models for raw  
materials strategy --- waste materials and scrap  
recycling 22 p0265 A79-24040  
Energy use patterns for metal recycling  
[PB-284855/4] 21 p0201 N79-13152
- SCREENS**  
Study of the temperature distribution across the  
width of the screen of low-temperature water  
heaters with tubular heat receivers 22 p0297 A79-28671
- SCRUBBERS**  
Stabilization of power plant scrubbing slurries  
and fine coal refuse with the additive Calcilor  
21 p0063 A79-14107  
Simultaneous nitrogen oxides and sulfur dioxide  
removal by absorption-reduction scrubbing  
21 p0066 A79-14125  
Particulate control mobile test units: Third  
year's operation [PB-283657/5] 21 p0178 N79-10603  
Evaluations of novel particulate control devices  
[PB-283973/6] 21 p0199 N79-12601
- Flue gas desulfurization system capabilities for  
coal-fired stream generators, volume 1.  
Executive summary [PB-284045/2] 21 p0200 N79-12606
- SEA WATER**  
Sea water desalination by means of solar energy  
21 p0057 A79-13645  
Power plant systems based on solar energy ---  
powered by sea water evaporation-produced  
osmotic pressure head mechanical energy 21 p0142 A79-17508
- SEALING**  
Energy conservation through sealing technology  
22 p0237 A79-20700
- SECONDARY FLOW**  
Limit of formation of counterflows in plane linear  
induction MHD machines 22 p0298 A79-29288
- SECURITY**  
Integrated safeguards information System (ISIS),  
executive summary --- nuclear power plant and  
fissionable materials security [PB-286869/3] 21 p0223 N79-14934  
The national energy plan: Options under  
assumptions of national security threat ---  
economic impact procurement policy, and  
resources management [R-PHINT-95-48] 21 p0228 N79-15398  
The national energy plan: Options under  
assumptions of national security threat or  
energy policy as if it really mattered  
[R-PHINT-95-42] 21 p0228 N79-15399
- SEDIMENTS**  
The effect of maturation on the configuration of  
pristane in sediments and petroleum 22 p0272 A79-25375
- SEEBECK EFFECT**  
Comprehensive thermoelectric properties of n- and  
p-type 78a/o Si - 22a/o Ge alloy 22 p0259 A79-23604
- SEEPAGE**  
Late diagenetic indicators of buried oil and gas.  
2: Direct detection experiment at Cement and  
Garza fields, Oklahoma and Texas, using enhanced  
LANDSAT 1 and 2 images [E79-10099] 22 p0347 N79-28373
- SEISMIC ENERGY**  
Energy and Technology Review, June 1978 --- 21 p012  
composite materials for flywheels, shale oil  
recovery, and seismic safety at nuclear power  
plants [UCRL-52000-78-6] 21 p0215 N79-14168
- SEISMOGRAPHS**  
Instrumentation for in situ coal gasification. IV  
- Seismic and acoustic techniques for remote  
monitoring 22 p0304 A79-29974
- SEISMOLOGY**  
Seismological investigations in geothermal regions  
22 p0356 N79-19506
- SELECTIVITY**  
Selective solar absorbers --- coatings for solar  
collector applications 21 p0057 A79-13646  
Colored stainless steel - A new type of selective  
absorber --- for solar thermal conversion 22 p0294 A79-28150  
Microstructural characterization of a black chrome  
solar selective absorber 22 p0294 A79-28151  
New instrumentation for high temperature and  
hemispherical measurements of selective surfaces  
--- for solar energy conversion 22 p0294 A79-28152
- SELENIDES**  
Selenide isotope generator for the Galileo mission  
21 p0022 A79-10185  
Selenide thermoelectric converter technology  
21 p0026 A79-10221  
Selenide technology evaluation program at JPL  
21 p0026 A79-10222  
Analytical predictions of selenide RTG power  
degradation 21 p0026 A79-10223  
Low voltage behavior of lithium/metal  
dichalcogenide topochemical cells 22 p0286 A79-26995

## SELENIUM COMPOUNDS

## SELENIUM COMPOUNDS

Silver selenate and silver tellurate as positive materials for lithium primary power sources 22 p0245 A79-21484

## SELF CONSISTENT FIELDS

The 'PINTOR 1' design - A minimum size tokamak experimental reactor 21 p0078 A79-14782

Self-consistent analysis of alpha-particle heating of a fast-solenoid plasma --- in laser fusion 22 p0291 A79-27879

## SELF FOCUSING

Self-adjusting laser-target system for laser fusion 21 p0086 A79-15625

Solar receiver performance of point focusing collector system [ASME PAPER 78-WA/SOL-5] 21 p0163 A79-19838

## SEMICONDUCTING FILMS

Large area silicon sheet by EPG --- Edge-defined Film-fed Growth 21 p0123 A79-17340

Transparent conducting coatings for solar cells 21 p0124 A79-17350

A pilot line for the production of large area Cu/x/S-CdS solar cells 21 p0124 A79-17351

A diagnostic study on the polycrystalline nature and its relationship with the yield of CdS solar cell 21 p0125 A79-17361

Preparation and properties of pure and tin doped indium oxide selective coatings 21 p0127 A79-17381

Grain-boundary edge passivation of GaAs films by selective anodization --- shorting effect in solar cells 21 p0154 A79-18487

Merocyanine organic solar cells 21 p0165 A79-20216

Calculating the photocurrent and maximum efficiency of film p-CdTe-n-CdS photocells 21 p0166 A79-20354

Heat exchanges and columnar growth in electron-beam evaporation of silicon films for solar cell applications 22 p0272 A79-25084

High-efficiency thin-film polycrystalline-silicon solar cells 22 p0273 A79-25744

The design and fabrication of CdS/Cu<sub>2</sub>S cells of 8.5-percent conversion efficiency 22 p0300 A79-29428

Black germanium solar selective absorber surfaces 22 p0327 A79-31970

## SEMICONDUCTOR DEVICES

High reliability contacts for miniature thermoelectric converters 21 p0027 A79-10228

Semiconductor electrodes for conversion and storage of solar energy 21 p0036 A79-11777

Role of semiconductor properties in photoelectrolysis 21 p0037 A79-11780

Progress and trends in the development of terrestrial photoelectric conversion 21 p0056 A79-13635

A new amorphous silicon-based alloy for electronic applications 21 p0100 A79-16226

Potential for low cost, high efficiency solar cells using indium tin oxide on semiconductor /OSOS/ solar cells 21 p0122 A79-17338

Analysis of the characteristics of silicon photoconverters in the 100-400 K temperature range 21 p0167 A79-20361

Charge transfer by surface states in the photoelectrolysis of water using a semiconductor electrode 22 p0254 A79-22320

Stability of work and sensitivity of semiconductor thermoelectric systems under automatic control 22 p0261 A79-23624

An investigation of dark current and photocurrent superposition in photovoltaic devices 22 p0291 A79-27871

## SUBJECT INDEX

Study of photoelectric characteristics of photocells made from high-resistivity silicon 22 p0296 A79-28666

Improved semiconductors for photovoltaic solar cells [DSE/2459-2] 21 p0221 A79-14577

## SEMICONDUCTOR DIODES

Simple high-accuracy diode temperature-difference control circuit 21 p0056 A79-13631

## SEMICONDUCTOR JUNCTIONS

Semiconductor liquid junction solar cells - Efficiency, electrochemical stability, and surface preparation 21 p0037 A79-11783

Investigation on junction formation and realisation of high open-circuit voltage in Cu/x/S-CdS solar cells 21 p0123 A79-17344

/SN/x-GaAs polymer-semiconductor solar cells 21 p0154 A79-18504

New models of solar cells and prospects for their optimization 21 p0166 A79-20346

Measurement techniques for solar cells [PB-287519/3] 22 p0343 A79-17352

## SEMICONDUCTORS (MATERIALS)

Photoelectrolysis of water with semiconductors 22 p0259 A79-23343

## SENSITIVITY

Inclination dependence of pyranometer sensitivity --- for solar collector testing 22 p0295 A79-28154

## SEPARATORS

Nickel-zinc vs. silver-zinc battery - A comparative study of baseline characteristics 21 p0009 A79-10083

## SERVICE LIFE

Silver-hydrogen, a long life light weight energy storage system --- design for spacecraft 21 p0001 A79-10012

Nickel-cadmium battery reconditioning and long term performance in geosynchronous orbit spacecraft 21 p0029 A79-10242

Development of a compact gas turbine combustor to give extended life and acceptable exhaust emissions 21 p0033 A79-10799

Reliability and durability of ceramic regenerators for gas turbine applications 21 p0050 A79-12823

Problems in the development of high-service-life capacitative accumulators --- for fusion reactors 22 p0243 A79-21249

Development of advanced fuel cell system [NASA-CR-159443] 21 p0196 A79-12553

## SET THEORY

Conference on Decision and Control, and Symposium on Adaptive Processes, 16th, and Special Symposium on Fuzzy Set Theory and Applications, New Orleans, La., December 7-9, 1977, Proceedings. Volumes 1 & 2 21 p0081 A79-14957

## SEWAGE

Co-disposal of sewage sludge using refuse-derived fuel 21 p0097 A79-16098

## SEWAGE TREATMENT

Use of solar energy to heat anaerobic digesters. Part 1: Technical and economic feasibility study. Part 2: Economic feasibility throughout the United States 21 p0231 A79-15440

Resource analysis: Water and energy as linked resources [PB-286940/2] 22 p0349 A79-18463

## SHADOWS

Tilt, orientation and overshadowing of solar collectors in the Netherlands 21 p0131 A79-17414

## SHALE OIL

Prerrefining true in situ shale oil 21 p0004 A79-10044

Jet fuels from shale oil - A near term technology 21 p0005 A79-10045

Colorado's oil-shale resource for vertical modified in-situ processes 21 p0005 A79-10046



- Comparison of shale oils from different sources produced by controlled-state retort 21 p0005 A79-10047
- Combustion rates for oil shale carbonaceous residue 21 p0032 A79-10522
- Alternative aircraft fuels 21 p0033 A79-10824
- Recovery of oil from oil shale - An overall technological perspective 21 p0073 A79-14698
- An economic analysis of synthetic fuels production from eastern oil shale via hydroretort processing 22 p0264 A79-23780
- Oil shale in the U.S. - Current state of technology and research 22 p0265 A79-23830
- Shale oil - The answer to the jet fuel availability question [SAF PAPER 781027] 22 p0274 A79-25900
- Oil shale retorting - A correlation of selected infrared absorbance bands with process heating rates and oil yield 22 p0304 A79-29975
- Technical and environmental aspects of oil shale processing 21 p0199 A79-12581
- Further studies of fuels from alternate sources: fire extinguishment experiments with JP-5 jet turbine fuel derived from shale [AD-A058586] 21 p0201 A79-13182
- EPA program status report: Oil shale [PB-284480/1] 21 p0211 A79-13548
- Energy and Technology Review, June 1978 --- composite materials for flywheels, shale oil recovery, and seismic safety at nuclear power plants [UCRL-52000-78-6] 21 p0215 A79-14168
- Behavior of nonmetallic materials in shale oil derived jet fuels and in high aromatic and high sulfur petroleum fuels --- compatibility of aircraft materials to fuels [AD-A060322] 21 p0226 A79-15203
- Water-related environmental effects in fuel conversion, volume 1. Summary [PB-288313/0] 22 p0351 A79-18834
- Aging behavior of crude shale oil [AD-A062420] 22 p0357 A79-20272
- SHALES**
- The effect of maturation on the configuration of pristane in sediments and petroleum 22 p0272 A79-25375
- SHALLOW WATER**
- Liquid desiccant solar air conditioner and energy storage system 21 p0021 A79-10176
- SHEETS**
- Recent developments in low cost silicon solar cells for terrestrial applications --- sheet production methods 22 p0239 A79-20821
- SHIPS**
- Progress towards 100-knot nonconventional ocean ships. II 21 p0155 A79-18519
- SHIVA LASER SYSTEM**
- Techniques for preventing damage to high power laser components --- Shiva laser fusion experiments 21 p0083 A79-15145
- Performance of the short-pulse oscillators for Argus and Shiva 21 p0083 A79-15171
- Diagnostics of Shiva Nova high-yield thermonuclear events --- in laser fusion 22 p0285 A79-26747
- SHOCK HEATING**
- New results in high-beta stellarator and belt-pinch research 21 p0070 A79-14463
- Shock-tube measurements of induction and post-induction rates for low-Btu gas mixtures --- derived from shale oil retorting and coal gasification 21 p0083 A79-15245
- SHOCK TUBES**
- Shock tube studies of coal devolatilization 21 p0083 A79-15247
- The MHD interaction and plasma properties in a shock tube driven disk generator with swirl 21 p0083 A79-15260
- SHOCK WAVE PROPAGATION**
- Analysis of a cylindrical imploding shock wave 21 p0155 A79-18846
- Nonstationary two-dimensional magnetohydrodynamic flow in a radial channel 22 p0247 A79-21626
- SHORT WAVE RADIATION**
- Measurement and modelling of shortwave radiation on inclined surfaces 22 p0242 A79-21062
- SIGNAL MEASUREMENT**
- Instrumentation for in situ coal gasification. IV - Seismic and acoustic techniques for remote monitoring 22 p0304 A79-29974
- SIGNAL MIXING**
- Generation of the new coherent radiation by harmonic conversion and nonlinear mixing for certain applications --- optical interactions 21 p0111 A79-16639
- SIGNAL PROCESSING**
- Data acquisition and signal processing for a vertical axis wind energy conversion system [SAND-78-1000C] 21 p0187 A79-11517
- SIGNAL STABILIZATION**
- Observation of voltage fluctuations in a Superconducting Magnet during MHD power generation 22 p0235 A79-20531
- SILICA GEL**
- Solid desiccant air conditioning with silica gel using solar energy 21 p0181 A79-11464
- SILICIDES**
- DC reactively sputtered metal carbide and metal silicide selective absorbing surfaces --- for photothermal solar energy conversion 21 p0126 A79-17377
- SILICON**
- Possibility of production of low cost solar grade silicon by trichlorosilane process 21 p0125 A79-17363
- Heat exchanges and columnar growth in electron-beam evaporation of silicon films for solar cell applications 22 p0272 A79-25084
- Chemical vapor deposited amorphous silicon for use in photothermal conversion 22 p0294 A79-28149
- Study of photoelectric characteristics of photocells made from high-resistivity silicon 22 p0296 A79-28666
- Cast semicrystalline silicon for solar cells [ASME PAPER 79-SOL-16] 22 p0309 A79-30550
- Development of high-efficiency P(+) - N-N(+) back-surface-field silicon solar cells [SAND-78-1156C] 21 p0188 A79-11529
- Silicon Schottky photovoltaic diodes for solar energy conversion [PB-283998/3] 21 p0198 A79-12572
- Novel duplex vapor electrochemical method for silicon solar cells [NASA-CR-158039] 21 p0218 A79-14537
- Silicon sheet growth development for the large area sheet task of the low cost solar array project. Heat exchanger method - ingot casting fixed abrasive method - multi-wire slicing [NASA-CR-158038] 21 p0219 A79-14540
- Pilot line report: Development of a high efficiency thin silicon solar cell [NASA-CR-158028] 21 p0219 A79-14548
- Development of a model and computer code to describe solar grade silicon production processes --- phase changes in chemical reactors [NASA-CR-158037] 21 p0219 A79-14555
- Slicing of silicon into sheet material: Silicon sheet growth development for the large area silicon sheet task of the Low Cost Silicon Solar Array project [NASA-CR-158082] 22 p0333 A79-16365
- Evaluation of the technical feasibility and effective cost of various wafer thicknesses for the manufacture of solar cells [NASA-CR-158095] 22 p0334 A79-16368
- LSA large area silicon sheet task continuous liquid feed Czochralski growth [NASA-CR-158366] 22 p0357 A79-20281

## SILICON ALLOYS

## SUBJECT INDEX

- Silicon web process development  
[NASA-CR-158376] 22 p0357 N79-20282
- The production of solar cell grade silicon from  
bromosilanes  
[NASA-CR-158362] 22 p0358 N79-20482
- Large area silicon sheet by EFG  
[NASA-CR-158379] 22 p0359 N79-20483
- Development of economical improved thick film  
solar cell contact  
[NASA-CR-158358] 22 p0359 N79-20486
- SILICON ALLOYS**
- Modified silicon-germanium alloys with improved  
performance --- thermoelectric material  
21 p0027 A79-10225
- A new amorphous silicon-based alloy for electronic  
applications  
21 p0100 A79-16226
- Comprehensive thermoelectric properties of n- and  
p-type 78a/o Si - 22a/o Ge alloy  
22 p0259 A79-23604
- Method of producing a p-type or n-type alloy for  
direct thermoelectric energy conversion  
22 p0260 A79-23615
- SILICON CARBIDES**
- Ceramic heat exchanger - Applications and  
developments  
21 p0050 A79-12826
- SILICON COMPOUNDS**
- Process feasibility study in support of silicon  
material task 1  
[NASA-CR-158034] 21 p0219 N79-14541
- SILICON FILMS**
- Ultra-thin silicon solar cells for high  
performance panel applications  
21 p0029 A79-10243
- Optimization of electrical and optical  
characteristics of silicon photocells used for  
photothermal concentrated solar radiation  
converters  
21 p0053 A79-13288
- High-efficiency thin-film polycrystalline-silicon  
solar cells  
22 p0273 A79-25744
- SILICON JUNCTIONS**
- Vertical junction silicon solar cell --- for  
spacecraft power sources  
21 p0001 A79-10013
- Trends in silicon solar-photovoltaic cells - An  
invited talk  
21 p0122 A79-17333
- A new fabrication process for single crystal  
silicon solar cells  
21 p0122 A79-17335
- Large area silicon sheet by EFG --- Edge-defined  
film-fed Growth  
21 p0123 A79-17340
- Design and fabrication of silicon solar cells for  
concentrated light  
21 p0124 A79-17352
- Efficiency of conventional silicon solar cells  
21 p0125 A79-17362
- On the role of interface states in MOS solar cells  
21 p0156 A79-19092
- Characteristics of silicon photoconverters with  
inversion layer  
21 p0166 A79-20349
- Effect of grain boundaries in silicon on  
minority-carrier diffusion length and solar-cell  
efficiency  
22 p0252 A79-21807
- Performance of a new high-intensity silicon solar  
cell  
22 p0257 A79-22862
- The interfacial layer in MIS amorphous silicon  
solar cells  
22 p0258 A79-23039
- The short-wavelength response of MIS solar cells  
22 p0273 A79-25748
- SILICON NITRIDES**
- Designing and testing Si<sub>3</sub>N<sub>4</sub> turbine components at  
Mercedes-Benz  
21 p0050 A79-12830
- Development of multi-density silicon nitride  
turbine rotors  
21 p0050 A79-12832
- Preliminary design of a subscale ceramic  
helical-rotor expander  
21 p0050 A79-12849
- Ceramics for the advanced automotive gas turbine  
engine - A look at a single shaft design  
21 p0050 A79-12850
- SILVER**
- Fabrication and testing of silver-hydrogen cells  
[NASA-CR-159431] 22 p0334 N79-16374
- SILVER COMPOUNDS**
- Silver selenate and silver tellurate as positive  
materials for lithium primary power sources  
22 p0245 A79-21484
- On the possibility of using silver salts other  
than Ag<sub>2</sub>CrO<sub>4</sub> in organic lithium cells  
22 p0246 A79-21491
- SILVER OXIDES**
- Silver-hydrogen, a long life light weight energy  
storage system --- design for spacecraft  
21 p0001 A79-10012
- SILVER ZINC BATTERIES**
- Nickel-zinc vs. silver-zinc battery - A  
comparative study of baseline characteristics  
21 p0009 A79-10083
- Evaluation of methods for analyzing silver-zinc  
cells  
21 p0010 A79-10085
- An improved method for analysis of hydroxide and  
carbonate in alkaline electrolytes containing zinc  
21 p0035 A79-11546
- SINGLE CRYSTALS**
- High efficiency solar cells based on indium  
phosphide  
21 p0042 A79-11968
- A new fabrication process for single crystal  
silicon solar cells  
21 p0122 A79-17335
- Design and fabrication of silicon solar cells for  
concentrated light  
21 p0124 A79-17352
- SINTERING**
- Effects of sintering on porous fuel cell electrodes  
21 p0039 A79-11818
- SITE DATA PROCESSORS**
- Wind power site evaluation. I - Wind energy  
potential. II - Data acquisition and processing  
22 p0257 A79-22924
- SITES**
- Wind energy conversion --- review discussing sites  
and machinery  
21 p0091 A79-15870
- A technique for longitudinal correlation of wind  
data - Theory and its application to siting of  
wind power plants  
21 p0143 A79-17518
- Tidal power plants - Sites, history and  
geographical distribution  
21 p0150 A79-18102
- Selection of optimum sites for tidal power  
development in the Bay of Fundy  
21 p0152 A79-18110
- Review of optimization and economic evaluation of  
potential tidal power developments in the Bay of  
Fundy  
21 p0152 A79-18111
- Solar energy - Four sites demonstrate potential  
22 p0328 A79-32194
- Reliability of wind power from dispersed sites: A  
preliminary assessment  
[LBL-6889] 21 p0176 N79-10547
- Siting handbook for small wind energy conversion  
systems  
[PBL-2521] 21 p0209 N79-13527
- Atlas of western surface-mined lands: Coal,  
uranium, and phosphate  
[PB-287846/0] 22 p0340 N79-17311
- Assessment of economic factors affecting the  
satellite power system. Volume 2: The systems  
implications of rectenna siting issues  
[NASA-CR-161196] 22 p0368 N79-21552
- SIZE DETERMINATION**
- Optimal sizing of solar collectors by the method  
of relative areas  
21 p0066 A79-14263
- Universal generator storer curves --- Economic and  
relative size optimization of solar photovoltaic  
energy  
22 p0238 A79-20799

# SUBJECT INDEX

# SOLAR ARRAYS

## SKY RADIATION

- Computation of IR sky temperature and comparison with surface temperature --- for solar collector energy budgets 21 p0042 A79-11875
- Irradiances on inclined surfaces --- from solar and sky radiation and earth albedo 21 p0055 A79-13624
- Diffuse solar radiation on a horizontal surface for a clear sky 22 p0242 A79-21167
- Isotropic distribution approximation in solar energy estimations --- diffuse insolation on tilted surface 22 p0262 A79-23753

## SLABS

- Periodic heating/cooling by solar radiation --- through concrete slab buildings 21 p0140 A79-17491

## SLAGS

- Coal slag effects in MHD generators 21 p0080 A79-14934
- Controlled utilization of coal slag in the MHD topping cycle 21 p0081 A79-14936
- Slag deposition and its effect on the performance of MHD channels --- in electric generators [AIAA PAPER 79-0189] 21 p0157 A79-19588
- Slag transport models for radiant heater of an MHD system [ASME PAPER 78-WA/HT-21] 21 p0161 A79-19808

## SLICING

- Slicing of silicon into sheet material: Silicon sheet growth development for the large area silicon sheet task of the Low Cost Silicon Solar Array project [NASA-CR-158082] 22 p0333 N79-16365

## SLOPES

- Optimum collector slope for residential heating in adverse climates 22 p0263 A79-23761
- Sensitivity of slope measurements on parabolic solar mirrors to positioning and alignment of the laser scanner [SAND-78-0700] 21 p0185 N79-11496
- Radiation regime of inclined surfaces [WHO-467] 21 p0192 N79-11613

## SLUDGE

- Co-disposal of sewage sludge using refuse-derived fuel 21 p0097 A79-16098
- Use of solar energy to heat anaerobic digesters. Part 1: Technical and economic feasibility study. Part 2: Economic feasibility throughout the United States [PB-286940/2] 21 p0231 N79-15440

## SLURRIES

- Stabilization of power plant scrubbing slurries and fine coal refuse with the additive Calcilox 21 p0063 A79-14107

## SMOKE

- A literature review-problem definition studies on selected toxic chemicals. Volume 8: Environmental aspects of diesel fuel and fog oils SGP number 1 and SGP number 2 and smoke screens generated from them [AD-A056021] 21 p0193 N79-11688

## SMOKE ABATEMENT

- Advanced emissions control and test facility of the Electric Power Research Institute 21 p0115 A79-17249

## SNOW

- Applying NASA remote sensing data to geologically related regional planning problems in Tennessee [E79-10095] 22 p0339 N79-17289

## SOCIAL FACTORS

- A multivariate-utility approach for selection of energy sources 21 p0098 A79-16120
- SPS microwave subsystem potential impacts and benefits --- environmental and societal effects of Solar Power System construction and operation 21 p0107 A79-16603
- Statement of Doctor Krafft A. Ehrlicke, President, Space Global, La Jolla, California 21 p0224 N79-15108

## SODIUM

- Performance of molten salt sodium/beta-alumina/SbCl3 cells 22 p0245 A79-21479
- Sodium-antimony trichloride battery development program for load leveling [EPRI-EH-751] 21 p0186 N79-11501

## SODIUM COMPOUNDS

- Electrochemical determinations of the chemical potential and diffusivity of sodium in Na<sub>2</sub>x/TaS<sub>2</sub> at 300 K 21 p0040 A79-11830

## SODIUM HYDROXIDES

- NaOH-based high temperature heat-of-fusion thermal energy storage device 21 p0012 A79-10106
- Phase change thermal storage for a solar total energy system 21 p0120 A79-17321
- Development of a phase-change thermal storage system using modified anhydrous sodium hydroxide for solar electric power generation [NASA-CR-159465] 22 p0354 N79-19454

## SODIUM NITRATES

- Phase change thermal storage for a solar total energy system 21 p0120 A79-17321

## SODIUM SULFUR BATTERIES

- A critical review and evaluation of published electric-vehicle performance data 21 p0009 A79-10081
- Pulse characteristics of sodium sulfur cells for electric vehicle propulsion 21 p0009 A79-10082
- Advanced batteries --- sodium sulfur batteries for electric motor vehicles 21 p0067 A79-14270
- The sodium/sulfur battery - A storage battery for peak load adjustment and electric traction 21 p0165 A79-20244
- Casing materials for sodium/sulfur cells 22 p0245 A79-21481
- Recent advances in Na/S cell development - A review 22 p0246 A79-21488
- Superbatteries - A progress report --- for utility energy storage and electric vehicles 22 p0286 A79-27207
- Development of sodium-sulfur batteries for utility application [EPRI-EH-683] 21 p0186 N79-11502
- SODIUM VAPOR Research on the sodium heat engine 21 p0028 A79-10231

## SOIL MAPPING

- Surtrace - An airborne geochemical system --- for earth surface micro-layer exploration 22 p0255 A79-22557

## SOILS

- Soil cooling for geothermal electric power plants in the Western United States - The Raft River experiment 22 p0266 A79-24240
- Environmental and radiological safety studies. Interaction of (Pu-238)02 heat sources with terrestrial and aquatic environments --- soil and water analysis [LA-7033-PR] 21 p0232 N79-15783
- Applying NASA remote sensing data to geologically related regional planning problems in Tennessee [E79-10095] 22 p0339 N79-17289

## SOLAR ARRAYS

- Status of wraparound contact solar cells and arrays --- for spacecraft electric propulsion 21 p0001 A79-10014
- Orbiting Solar Observatory /OSO-8/ solar panel design and in-orbit performance 21 p0001 A79-10017
- Intelsat V solar array design and development summary 21 p0002 A79-10018
- Ultralow-mass solar-array designs for Halley's comet rendezvous mission 21 p0020 A79-10169
- Cost minimization of photovoltaic power supplies 21 p0021 A79-10171
- Photovoltaic concentrating array 21 p0021 A79-10172
- Development and testing of the ULP solar array 21 p0029 A79-10245

## SOLAR CELLS

## SUBJECT INDEX

- Advancements in the design of solar array to battery charge current regulators 21 p0033 A79-10902
- Roll-out solar arrays - Candidate power sources for future space missions [IAF PAPER 78-39] 21 p0034 A79-11216
- New design verification aspects of large flexible solar arrays [IAF PAPER 78-217] 21 p0035 A79-11298
- Design optimization for solar array of multiple collector types 21 p0071 A79-14677
- Determining optimal angles of nonconvex solar battery panel mounting 21 p0080 A79-14837
- Practical considerations for 'capturing the sun' 21 p0089 A79-15853
- Status of photovoltaic systems and applications 21 p0095 A79-15907
- Shading and spacing in paraboloidal collector arrays 21 p0150 A79-18025
- Integral assembly of photovoltaic arrays using glass 22 p0241 A79-20883
- The application of thermography to large arrays of solar energy collectors 22 p0242 A79-21171
- Energy storage requirements for spacecraft 22 p0246 A79-21486
- Solar thermal electric power systems - Comparison of line-focus collectors 22 p0263 A79-23758
- Solar-cell panel simulator 22 p0265 A79-23867
- Encapsulant materials for \$2/watt terrestrial photovoltaic arrays 22 p0266 A79-24138
- Enhanced power generation by optical solar reflectors on geostationary spinners 22 p0272 A79-25138
- The effect of the dispersion of the characteristics of solar cells in large systems 22 p0285 A79-26822
- Do photovoltaics have a future [ASME PAPER 79-SOL-7] 22 p0308 A79-30543
- Photovoltaic concentrator system technology and applications experiments [ASME PAPER 79-SOL-9] 22 p0308 A79-30544
- Structural cost optimization of photovoltaic central power station modules and support structure [ASME PAPER 79-SOL-17] 22 p0309 A79-30551
- Dynamics of stepping of the Hermes flexible solar array 22 p0323 A79-31615
- Solar array systems 21 p0169 N79-10131
- Solar array workshop 21 p0170 N79-10142
- Effect of solar cell parameter variation on array power output [SAND-78-0917C] 21 p0188 N79-11527
- Assessment of SEPS solar array technology for orbital service module application [NASA-CR-151859] 21 p0194 N79-12136
- Encapsulation task of the low-cost silicon solar array project. Investigation of test methods, material properties, and processes for solar cell encapsulants [NASA-CR-157939] 21 p0195 N79-12544
- Parametric study of two planar high power flexible solar array concepts [NASA-CR-157841] 21 p0205 N79-13501
- Design of low-cost structures for photovoltaic arrays. Task 1: Survey of array structural characteristics [SAND-78-7021] 21 p0206 N79-13509
- Silicon sheet growth development for the large area sheet task of the low cost solar array project. Heat exchanger method - ingot casting fixed abrasive method - multi-wire slicing [NASA-CR-158038] 21 p0219 N79-14540
- Concentrator enhanced solar arrays design study [NASA-CR-158032] 21 p0219 N79-14546
- Conceptual approach study 200 watt per kilogram solar array, phase 3 [NASA-CR-158046] 21 p0219 N79-14551
- The 25 kW power module updated baseline system --- for space transportation system payloads [NASA-TN-78212] 21 p0226 N79-15247
- Continuous Czochralski growth: Silicon sheet growth development of the large area silicon sheet task of the Low Cost Silicon Solar Array project [NASA-CR-158096] 22 p0334 N79-16369
- Analysis and evaluation of process and equipment in tasks 2 and 4 of the Low Cost Solar Array project [NASA-CR-158089] 22 p0335 N79-16378
- Study on solar arrays for programmes leading from the extension of Spacelab towards space platforms [ESS/SS-878] 22 p0335 N79-16379
- An improved solar panel and method for fabricating the same [NASA-CASE-WPO-14490-1] 22 p0348 N79-18445
- Phase 1 of the automated array assembly task of the low cost silicon solar array project [NASA-CR-158120] 22 p0348 N79-18451
- LSA Low-cost Solar Array project [NASA-CR-158250] 22 p0355 N79-19462
- Closed Loop solar array-ion thruster system with power control circuitry [NASA-CASE-LEW-12780-1] 22 p0357 N79-20179
- Automated array assembly, phase 2 [NASA-CR-158360] 22 p0358 N79-20480
- Automated array assembly, phase 2. Low-cost solar array project, task 4 [NASA-CR-158365] 22 p0358 N79-20481
- Phase two of the array automated assembly task for the low cost solar array project [NASA-CR-158359] 22 p0359 N79-20484
- Feasibility study of solar dome encapsulation of photovoltaic arrays [NASA-CR-158368] 22 p0367 N79-21545
- The 100 kW space station --- regenerative fuel cells and nickel hydrogen and nickel cadmium batteries for solar arrays 22 p0371 N79-21603
- The 25 kW space station 22 p0371 N79-21604
- SOLAR CELLS**
- Vertical junction silicon solar cell --- for spacecraft power sources 21 p0001 A79-10013
- Status of wraparound contact solar cells and arrays --- for spacecraft electric propulsion 21 p0001 A79-10014
- The NTS-2 satellite solar cell experiment 21 p0001 A79-10016
- The application of photovoltaic roof shingles to residential and commercial buildings 21 p0020 A79-10170
- Photovoltaic concentrating array 21 p0021 A79-10172
- Ultra-thin silicon solar cells for high performance panel applications 21 p0029 A79-10243
- Semiconductor electrodes for conversion and storage of solar energy 21 p0036 A79-11777
- Semiconductor liquid junction solar cells - Efficiency, electrochemical stability, and surface preparation 21 p0037 A79-11783
- n-CdS/n-GaAs photoanode --- electrochemical solar cells 21 p0037 A79-11784
- Optimum antireflection coating for Antireflection-coated Metal-Oxide-Semiconductor /AMOS/ solar cells 21 p0042 A79-11955
- Recent progress in thin film polycrystalline solar cells based on cadmium sulfide 21 p0042 A79-11966
- High efficiency solar cells based on indium phosphide 21 p0042 A79-11968
- High efficiency low cost solar cell power 21 p0048 A79-12471
- Optimization of electrical and optical characteristics of silicon photocells used for photothermal concentrated solar radiation converters 21 p0053 A79-13288
- Progress and trends in the development of terrestrial photoelectric conversion 21 p0056 A79-13635

## SUBJECT INDEX

## SOLAR CELLS CONTD

- Activities in the field of solar cells in the  
Federal Republic of Germany 21 p0056 A79-13636
- Cu<sub>2</sub>S-CdS thin-film solar cells 21 p0057 A79-13637
- Practical applications of silicon solar cells in  
appliances and installations 21 p0057 A79-13638
- Photovoltaic overview  
[AIAA PAPER 78-1763] 21 p0061 A79-13864
- Electricity from sunlight --- low cost silicon for  
solar cells 21 p0065 A79-14116
- Performance of a tilted solar cell under various  
atmospheric conditions 21 p0066 A79-14261
- Partial energy supply to electric vehicles through  
solar cell system 21 p0077 A79-14767
- The photovoltaic effect in CdS/Cu<sub>2</sub>S solar cells 21 p0091 A79-15871
- Overview of novel photovoltaic conversion  
techniques at high intensity levels 21 p0108 A79-16610
- Multicolor solar cell power system for space 21 p0108 A79-16611
- Trends in silicon solar-photovoltaic cells - An  
invited talk 21 p0122 A79-17333
- A new fabrication process for single crystal  
silicon solar cells 21 p0122 A79-17335
- Role of high performance solar cells in practical  
photovoltaic systems 21 p0122 A79-17336
- On the role of interface states in MOS solar cells 21 p0122 A79-17337
- Potential for low cost, high efficiency solar  
cells using indium tin oxide on semiconductor  
/OSOS/ solar cells 21 p0122 A79-17338
- Amorphous semiconductors in photovoltaic and solar  
thermal conversion 21 p0122 A79-17339
- Characterisation of amorphous semiconductor  
materials for solar cell applications 21 p0123 A79-17341
- Interface properties and stability of Schottky  
barriers and MIS solar cells 21 p0123 A79-17342
- Photovoltaic effect in  
metal-insulator-semiconductor structure 21 p0123 A79-17343
- Investigation on junction formation and  
realisation of high open-circuit voltage in  
Cu/x/S-CdS solar cells 21 p0123 A79-17344
- Improvement of efficiency and stability by  
copper-treatment and front contacting of  
Cu/x/S-CdS solar cells 21 p0123 A79-17345
- Sprayed CdS thin films for CdS/Cu<sub>2</sub>S heterojunction  
solar cells 21 p0123 A79-17346
- The photovoltaic effects in CdS/Cu<sub>2</sub>S solar cells 21 p0123 A79-17347
- Role of the diode exponential factor in CdS solar  
cells 21 p0123 A79-17348
- Stoichiometric Cu<sub>2</sub>S thin films for solar cells 21 p0123 A79-17349
- Transparent conducting coatings for solar cells 21 p0124 A79-17350
- A pilot line for the production of large area  
Cu/x/S-CdS solar cells 21 p0124 A79-17351
- Design and fabrication of silicon solar cells for  
concentrated light 21 p0124 A79-17352
- Response of p-n junction solar cells to  
concentrated sunlight and partial illumination 21 p0124 A79-17353
- Transcell, a novel approach for improving static  
photovoltaic concentration 21 p0124 A79-17356
- Response of a solar cell to intense and nonuniform  
illumination when used with solar concentrators 21 p0125 A79-17357
- Sensitivity calculations for the design of solar  
cells. I - Schottky barrier devices 21 p0125 A79-17360
- A diagnostic study on the polycrystalline nature  
and its relationship with the yield of CdS solar  
cell 21 p0125 A79-17361
- Efficiency of conventional silicon solar cells 21 p0125 A79-17362
- Possibility of production of low cost solar grade  
silicon by trichlorosilane process 21 p0125 A79-17363
- Saur vidyut kosh - The solar cell --- reversible  
charging electrolytic batteries 21 p0126 A79-17371
- A cost effective total energy system using a  
faceted mirror sunlight concentrator and high  
intensity solar cells 21 p0135 A79-17446
- Reliability studies on MIS solar cells 21 p0148 A79-17950
- Progress in batteries and solar cells. Volume 1  
--- Book 21 p0148 A79-17989
- The development of photovoltaic conversion systems  
with sunlight concentration 21 p0148 A79-17995
- Solar cell modules for terrestrial use 21 p0149 A79-17996
- General view of low cost solar cell development in  
Japan 21 p0149 A79-17997
- Econometric analysis of concentrators for solar  
cells 21 p0149 A79-18017
- Grain-boundary edge passivation of GaAs films by  
selective anodization --- shorting effect in  
solar cells 21 p0154 A79-18487
- Photoacoustic determination of photovoltaic energy  
conversion efficiency 21 p0154 A79-18503
- /SN/x-GaAs polymer-semiconductor solar cells 21 p0154 A79-18504
- On the role of interface states in MOS solar cells 21 p0156 A79-19092
- Merocyanine organic solar cells 21 p0165 A79-20216
- New models of solar cells and prospects for their  
optimization 21 p0166 A79-20346
- Photoelectric properties of pCdTe-nCdS film  
heterojunctions 21 p0166 A79-20347
- Characteristics of silicon photoconverters with  
inversion layer 21 p0166 A79-20349
- Calculating the photocurrent and maximum  
efficiency of film p-CdTe-n-CdS photocells 21 p0166 A79-20354
- Analysis of the characteristics of silicon  
photoconverters in the 100-400 K temperature range 21 p0167 A79-20361
- Recent developments in low cost silicon solar  
cells for terrestrial applications --- sheet  
production methods 22 p0239 A79-20821
- Effect of grain boundaries in silicon on  
minority-carrier diffusion length and solar-cell  
efficiency 22 p0252 A79-21807
- Materials for low-cost solar cells 22 p0252 A79-22099
- The Sunship --- solar powered airship design 22 p0254 A79-22324
- Temperature dependence of photovoltaic solar  
energy conversion for GaAs homojunction solar cell 22 p0256 A79-22768
- A two-junction cascade solar-cell structure 22 p0256 A79-22856
- Explanation for low-efficiency Cu<sub>2</sub>O  
Schottky-barrier solar cells 22 p0256 A79-22859
- Performance of a new high-intensity silicon solar  
cell 22 p0257 A79-22862
- The interfacial layer in MIS amorphous silicon  
solar cells 22 p0258 A79-23039

## SOLAR CELLS CONTD

## SUBJECT INDEX

- High-efficiency AlGaAs/GaAs concentrator solar cells 22 p0261 A79-23710
- Solar-cell panel simulator 22 p0265 A79-23867
- Angle-of-incidence effects in electron-beam-deposited SnO<sub>2</sub>/Si solar cells 22 p0272 A79-25069
- Heat exchanges and columnar growth in electron-beam evaporation of silicon films for solar cell applications 22 p0272 A79-25084
- High-efficiency thin-film polycrystalline-silicon solar cells 22 p0273 A79-25744
- Series resistance effects in GaAl/As/GaAs concentrator solar cells 22 p0273 A79-25745
- The short-wavelength response of MIS solar cells 22 p0273 A79-25748
- A better approach to the evaluation of the series resistance of solar cells 22 p0281 A79-26242
- Diffusion length measurements in Schottky barrier GaAs solar cells 22 p0281 A79-26243
- The effect of the dispersion of the characteristics of solar cells in large systems 22 p0285 A79-26822
- Production and application of rolling-welded aluminum alloy panels for solar water heaters for hot water and cooling systems 22 p0297 A79-28670
- Application of the superposition principle to solar-cell analysis 22 p0300 A79-29426
- The design and fabrication of CdS/Cu<sub>2</sub>S cells of 8.5-percent conversion efficiency 22 p0300 A79-29428
- Ga<sub>1-x</sub>Al<sub>x</sub>/As-GaAs photovoltaic cells with multilayer structure --- heterostructure solar cell fabrication 22 p0305 A79-30258
- The limiting efficiency of an edge-illuminated multijunction solar cell 22 p0305 A79-30259
- Do photovoltaics have a future [ASME PAPER 79-SOL-7] 22 p0308 A79-30543
- An overview of photovoltaic power systems [ASME PAPER 79-SOL-12] 22 p0308 A79-30547
- Unique aspects of terrestrial photovoltaic system design [ASME PAPER 79-SOL-14] 22 p0308 A79-30548
- Low cost thin-film CdS-based solar cells progress and promise [ASME PAPER 79-SOL-15] 22 p0309 A79-30549
- Cast semicrystalline silicon for solar cells [ASME PAPER 79-SOL-16] 22 p0309 A79-30550
- Effects of minority-carrier storage at the interface states on the fill factor of m.i.s. solar cells 22 p0313 A79-31347
- Measuring the quasi-Fermi level and flat band potential of an illuminated Au/n-GaAs/.6/P/.4/ anode --- for solar cells 22 p0317 A79-31411
- Photovoltaic properties of metal-free phthalocyanines - Al/H<sub>2</sub>Pc Schottky barrier solar cells 22 p0317 A79-31412
- Solar cell workshop 21 p0170 A79-10141
- Development of high-efficiency P(+)-N(-) back-surface-field silicon solar cells [SAND-78-1156C] 21 p0188 A79-11529
- Characterization of solar cells for space applications. Volume 4: Electrical characteristics of Spectrolab BSF 200-micron Helios cells as a function of intensity and temperature [NASA-CR-157934] 21 p0195 A79-12543
- Encapsulation task of the low-cost silicon solar array project. Investigation of test methods, material properties, and processes for solar cell encapsulants [NASA-CR-157939] 21 p0195 A79-12544
- Silicon Schottky photovoltaic diodes for solar energy conversion [PB-283998/3] 21 p0198 A79-12572
- Silicon solar cells, volume 2. Citations from the NTIS data base [NTIS/PS-78/1114/4] 21 p0212 A79-13554
- Silicon solar cells, volume 3. Citations from the NTIS data base [NTIS/PS-78/1115/1] 21 p0212 A79-13555
- Silicon solar cells, volume 2. Citations from the NTIS data base [NTIS/PS-78/1116/9] 21 p0212 A79-13556
- Solar electric power generation, volume 2. Citations from the NTIS data base [NTIS/PS-78/1108/6] 21 p0212 A79-13557
- Back wall solar cell [NASA-CASE-LEW-12236-2] 21 p0217 A79-14528
- Novel duplex vapor electrochemical method for silicon solar cells [NASA-CR-158039] 21 p0218 A79-14537
- Process feasibility study in support of silicon material task 1 [NASA-CR-158034] 21 p0219 A79-14541
- Pilot line report: Development of a high efficiency thin silicon solar cell [NASA-CR-158028] 21 p0219 A79-14548
- Development of a model and computer code to describe solar grade silicon production processes --- phase changes in chemical reactors [NASA-CR-158037] 21 p0219 A79-14555
- Improved semiconductors for photovoltaic solar cells [DSE/2459-2] 21 p0221 A79-14577
- Cadmium sulfide solar cells. Citations from the NTIS data base [NTIS/PS-78/1213/4] 21 p0231 A79-15436
- Cadmium sulfide solar cells. Citations from the Engineering Index Data base [NTIS/PS-78/1214/2] 21 p0231 A79-15437
- Industrialization study, phase 2 --- assessment of advanced photovoltaic technologies for commercial development [NASA-CR-158015] 22 p0333 A79-16351
- GaAs solar cell development [NASA-CR-158090] 22 p0334 A79-16366
- Continuous Czochralski growth: Silicon sheet growth development of the large area silicon sheet task of the Low Cost Silicon Solar Array project [NASA-CR-158096] 22 p0334 A79-16369
- Analysis and evaluation of process and equipment in tasks 2 and 4 of the Low Cost Solar Array project [NASA-CR-158089] 22 p0335 A79-16378
- Study on solar arrays for programmes leading from the extension of Spacelab towards space platforms [ESS/SS-878] 22 p0335 A79-16379
- Silicon Schottky photovoltaic diodes for solar energy conversion [PB-287417/0] 22 p0343 A79-17349
- Measurement techniques for solar cells [PB-287519/3] 22 p0343 A79-17352
- Block 4 solar cell module design and test specification for residential applications [NASA-CR-158117] 22 p0348 A79-18453
- Optical coatings for solar cells and solar collectors. Citations from the NTIS data base [NTIS/PS-78/1341/3] 22 p0350 A79-18465
- Optical coatings for solar cells and solar collectors. Citations from the Engineering index data base [NTIS/PS-78/1342/1] 22 p0350 A79-18466
- V-groove multijunction solar cells 22 p0353 A79-19445
- Solar cell module assembly jig [NASA-CASE-IGS-00829-1] 22 p0353 A79-19447
- Market definition studies for photovoltaic highway applications [NASA-CR-159477] 22 p0354 A79-19451
- Development of an improved high efficiency thin silicon solar cell [NASA-CR-158172] 22 p0354 A79-19459
- Thermal and other tests of photovoltaic modules performed in natural sunlight [NASA-CR-158174] 22 p0354 A79-19460
- LSA large area silicon sheet task continuous liquid feed Czochralski growth [NASA-CR-158366] 22 p0357 A79-20281
- Silicon web process development [NASA-CR-158376] 22 p0357 A79-20282
- The production of solar cell grade silicon from bromosilanes [NASA-CR-158362] 22 p0358 A79-20482

# SUBJECT INDEX

# SOLAR COLLECTORS

- Large area silicon sheet by EFG  
[NASA-CR-158379] 22 p0359 N79-20483
- Silicon solar cell process development,  
fabrication and analysis  
[NASA-CR-158363] 22 p0359 N79-20485
- Development of economical improved thick film  
solar cell contact  
[NASA-CR-158358] 22 p0359 N79-20486
- Satellite power system: Concept development and  
evaluation program, reference system report  
[NASA-TN-80413] 22 p0367 N79-21538
- A study of the effective resistance of the  
diffused layer and its effect on solar cell  
performance 22 p0367 N79-21541
- Material growth and characterization directed  
toward improving III-V heterojunction solar cells  
[NASA-TN-158476] 22 p0367 N79-21543
- SOLAR COLLECTORS**
- NaOH-based high temperature heat-of-fusion thermal  
energy storage device 21 p0012 A79-10106
- Liquid metal heat pipes for the central solar  
receiver 21 p0014 A79-10114
- Cost effective solar collectors using heat pipes  
21 p0014 A79-10115
- Design, construction, and testing of a Fixed  
Mirror Solar Concentrator field 21 p0020 A79-10164
- Thermal performance trade-offs for point focusing  
solar collectors 21 p0020 A79-10165
- Measurement of heat loss from a heat receiver  
assembly of a Fixed Mirror Solar Concentrator  
21 p0020 A79-10166
- Effects of pointing errors on receiver performance  
for parabolic dish solar concentrators 21 p0020 A79-10167
- Transient energy removal in cylindrical parabolic  
collector systems 21 p0020 A79-10168
- Comparative evaluation of distributed-collector  
solar thermal electric power plants 21 p0021 A79-10173
- Hybrid air to water solar collector design  
21 p0021 A79-10174
- Central solar heat stations and the Studsvik  
Demonstration Plant 21 p0021 A79-10175
- Thermosyphon solar water heating system under  
Brazilian conditions 21 p0021 A79-10177
- Heat pipe central solar receiver gas turbine plant  
21 p0022 A79-10178
- Simulation of solar powered Rankine cycle systems  
21 p0022 A79-10179
- The fossil fuel cost of solar heating  
21 p0022 A79-10180
- Operating experience at the DOE/Sandia  
wide-temperature Solar Systems Test Facility  
21 p0022 A79-10182
- Pylon panels - A technical report --- fiberglass  
reinforced plastics for solar collectors 21 p0031 A79-10403
- Application of composite materials in the solar  
energy domain 21 p0034 A79-11195
- Perspectives on utility central station  
photovoltaic applications 21 p0041 A79-11873
- Computation of IR sky temperature and comparison  
with surface temperature --- for solar collector  
energy budgets 21 p0042 A79-11875
- An approximate equation for predicting the solar  
transmittance of transparent honeycombs 21 p0042 A79-11877
- Effect of surface curvature on measurement of the  
absorptance properties of solar coatings 21 p0042 A79-11879
- Annual available radiation for fixed and tracking  
collectors 21 p0042 A79-11880
- A vacuum solar thermal collector with optimal  
concentration 21 p0043 A79-11970
- Optical evaluation techniques for reflecting solar  
concentrators 21 p0043 A79-11971
- Nonimaging solar concentrators 21 p0043 A79-11973
- Comparison of the solar concentrating properties  
of truncated hexagonal, pyramidal and circular  
cones 21 p0043 A79-11974
- Frequency doubling of a solar pumped Nd:YAG laser  
21 p0044 A79-12062
- A problem of optimizing the setting angle of  
sun-battery panels of concave shape --- onboard  
satellite 21 p0045 A79-12186
- High efficiency low cost solar cell power  
21 p0048 A79-12471
- Selling solar energy as a cash crop 21 p0049 A79-12725
- General principles of multielement concentrating  
system design --- solar collectors 21 p0054 A79-13291
- Facility with sectioned photoreceiver and laser  
radiator for determining solar radiation  
concentrator accuracy characteristics 21 p0054 A79-13292
- Selection of method for calculating the parameters  
of wind and solar power station storage facilities  
21 p0054 A79-13293
- Performance of a honeycomb type flat plate  
collector with serpentine tube 21 p0054 A79-13579
- Solar radiation simulation by means of solar  
simulator for the indoor testing of solar  
collectors 21 p0055 A79-13620
- Sun-position diagrams using examples from  
Flensburg to Mittenwald 21 p0055 A79-13626
- Testing the efficiency of solar collectors  
21 p0056 A79-13627
- Dynamic behaviour of light-weight solar collectors  
21 p0056 A79-13628
- Electronic components in solar technology  
21 p0056 A79-13629
- Solar power plants in the U.S.A. 21 p0057 A79-13640
- Experimental results and concepts of different  
solar concentrators 21 p0057 A79-13643
- Sea water desalination by means of solar energy  
21 p0057 A79-13645
- Selective solar absorbers --- coatings for solar  
collector applications 21 p0057 A79-13646
- Reduction of the heat loss flux of collectors by  
infrared reflecting coatings on cover plates  
21 p0058 A79-13649
- Flexed beams in central receiver heliostat drives  
[AIAA PAPER 78-1755] 21 p0060 A79-13856
- The ClearView Solar Collector system and  
associated one and two stage evaporative cooling  
- Interim results 21 p0061 A79-13860
- Jet impingement solar air heater  
[AIAA PAPER 78-1760] 21 p0061 A79-13861
- Design of a second generation concentrating  
tracking solar collector [AIAA PAPER 78-1775] 21 p0062 A79-13872
- Simulations of the performance of open cycle  
desiccant systems using solar energy 21 p0066 A79-14262
- Optimal sizing of solar collectors by the method  
of relative areas 21 p0066 A79-14263
- Use of plastics in solar energy applications  
21 p0067 A79-14268
- Estimating hourly solar radiation for one-axis  
tracking focusing collectors 21 p0071 A79-14678
- An inexpensive multiplexer temperature measuring  
system for monitoring and evaluation of solar  
collectors 21 p0089 A79-15847
- External single pass to superheat receiver --- for  
central receiver solar power plant  
[AIAA PAPER 78-1751] 21 p0089 A79-15849

## SOLAR COLLECTORS CONTD

Boosting the performance of solar HVAC systems by improving component interactions --- Heating, Ventilating and Air Conditioning 21 p0089 A79-15851

Practical considerations for 'capturing the sun' 21 p0089 A79-15853

Long-term average performance of the Sunpak evacuated-tube collector 21 p0089 A79-15854

Performance of evacuated solar collectors with compound parabolic concentrators 21 p0089 A79-15855

Tracking high temperature collectors 21 p0090 A79-15856

Solar energy and the flat plate collector - An annotated bibliography 21 p0090 A79-15858

A central receiver solar thermal power system 21 p0091 A79-15872

Simple procedure for predicting long term average performance of nontracking and of tracking solar collectors 21 p0091 A79-15873

10-megawatt solar central receiver pilot plant 21 p0094 A79-15906

Hail risk model for solar collectors 21 p0098 A79-16103

Verification of wedge concentration using a helium neon laser --- solar collector design 21 p0098 A79-16104

Simulated hail impact testing of photovoltaic solar panels 21 p0098 A79-16116

American Society of Heating, Refrigerating and Air-Conditioning Engineers, Annual Meeting, Albuquerque, N. Mex., June 25-29, 1978, Technical and Symposium Papers 21 p0101 A79-16415

The use and limitations of ASHRAE solar algorithms in solar energy utilization studies 21 p0101 A79-16416

Testing of solar collectors according to ASHRAE Standard 93-77 21 p0101 A79-16417

Controls for residential solar heating 21 p0101 A79-16418

Solar controls and control modifications - New Century town solar homes, Vernon Hills, IL 21 p0102 A79-16419

Using controls to reduce component size and energy needs for solar HVAC --- Heating Ventilation, Air Conditioning 21 p0102 A79-16421

A graphical approach to the efficiency of flat-plate collectors 21 p0102 A79-16422

The application of ASHRAE Standard 93-77 to the thermal performance testing of air solar collectors 21 p0102 A79-16423

Performance of vacuum tube solar collector systems 21 p0102 A79-16424

The El Camino Real Solar Cooling Demonstration Project 21 p0102 A79-16425

Solar collectors. I - Fundamentals and collectors of the past and present 21 p0103 A79-16455

Solar collectors. II - Recent developments and future performance data and economic analysis 21 p0103 A79-16456

Solar thermal conversion 21 p0104 A79-16466

Analysis of optical behavior and collector performance of a solar concentrator 21 p0107 A79-16545

Radiatively sustained cesium plasmas for solar electric conversion 21 p0109 A79-16615

Magnetically confined plasma solar collector --- satellite based system in space 21 p0109 A79-16617

Solar Thermal Electric Program 21 p0112 A79-16730

A status report on the Solar Thermal Test Facility 21 p0112 A79-16731

Factors affecting market initiation of solar total energy 21 p0112 A79-16732

## SUBJECT INDEX

Non-adaptive optics for solar thermal electric power 21 p0112 A79-16733

Estimation of collector and electrical energy cost for STEPS in Japan --- Solar Thermal Electric Power System 21 p0118 A79-17288

Solar radiation studies for utilization of flat-plate collectors in an equatorial region 21 p0119 A79-17311

Energy storage requirements for autonomous and hybrid solar thermal electric power plants 21 p0120 A79-17315

A passive integrated unit for the collection, thermal storage in fusion materials and distribution of solar energy for home heating and other applications 21 p0121 A79-17322

Analysis of thermal storage unit for solar energy 21 p0122 A79-17332

Concentrator photovoltaic systems for economical electricity and heat 21 p0124 A79-17354

On the design of CPC photovoltaic solar collectors --- Compound Parabolic Concentrator 21 p0124 A79-17355

Transcell, a novel approach for improving static photovoltaic concentration 21 p0124 A79-17356

Status report on selective surfaces --- solar collector absorbers 21 p0126 A79-17374

Selective coatings for solar energy conversion 21 p0126 A79-17376

Studies on the selective absorption surface on stainless steel --- for flat type solar collectors 21 p0127 A79-17378

On the use of grating or mesh selective filters to increase the efficiency of flat plate solar collectors 21 p0127 A79-17380

The structure and properties of Cu based selective surfaces formed on an Al-Cu alloy by chemical brightening and etching treatments --- for flat plate solar collectors 21 p0127 A79-17384

A heat pipe collector for low temperatures 21 p0127 A79-17385

Optimum collection geometries for copper tube - copper sheet flat plate collectors 21 p0127 A79-17387

An analytical and experimental study of pumped solar water heaters 21 p0128 A79-17389

Flat plate collector dynamic evaluation 21 p0128 A79-17390

A parametric investigation on flat-plate solar collectors 21 p0128 A79-17391

A comparison among various flat plate collectors with honeycomb structures 21 p0128 A79-17392

Comparative outdoor measurements on flat-plate solar collectors in a metropolitan area in Western Germany 21 p0128 A79-17394

Reflecting horizontal collector 21 p0128 A79-17395

Economic use of materials in the design of solar water-heating collector plates of the pipe and fin type 21 p0129 A79-17396

Performance of flat plate solar collector with fluid undergoing phase change 21 p0129 A79-17397

An interferometric investigation heat transfer in honeycomb solar collector cells 21 p0129 A79-17398

Effect of dust on flat plate collectors 21 p0129 A79-17399

Convective effects in 'slat collectors' 21 p0129 A79-17400

Simulation study of natural convection heat transfer in inclined air layers with application to solar energy collection 21 p0129 A79-17401

Effect of buoyancy and tube inclination on heat transfer in a solar air heater 21 p0129 A79-17402



- Thermal performance of solar collectors used in the national solar heating and cooling demonstration program 21 p0130 A79-17403
- Some aspects towards the performance evaluation and ensuing design components of solar collector systems 21 p0130 A79-17404
- Comparative performance testing of flat-plate solar water heaters 21 p0130 A79-17405
- Thermal performance testing of flat-plate solar collectors 21 p0130 A79-17407
- Optimal profile of solar energy collectors 21 p0130 A79-17408
- The testing procedures of thermal performance of solar collector at Solar Research Lab., G.I.R.I. 21 p0130 A79-17409
- Testing of water-heating collectors according to ASHRAE Standard 93-77 21 p0130 A79-17410
- Double-exposure collector system for solar heating applications 21 p0131 A79-17411
- Solar thermal collectors using planar reflector 21 p0131 A79-17412
- Tilt, orientation and overshadowing of solar collectors in the Netherlands 21 p0131 A79-17414
- Annual collection and storage of solar energy for the heating of buildings 21 p0131 A79-17415
- Field performance of certain selective and neutral surfaces in solar collectors 21 p0131 A79-17417
- Solar collector optimization 21 p0132 A79-17418
- Design and optimization of a flat plate collector for cooling application 21 p0132 A79-17419
- Anticonvective antiradiative systems --- for solar collectors 21 p0132 A79-17420
- Optimum tube pitch in solar collectors 21 p0132 A79-17421
- Optimising the pitching of tubes in a flat solar collector for increasing the efficiency for use in vapour absorption refrigeration 21 p0132 A79-17422
- A report on the various heat collection and heat storage systems evolved under the solar energy programme at B. I. T. S. 21 p0132 A79-17423
- Honeycomb type flat plate collectors - Experiments leading to drinking straw --- heat retention material for solar steam generation 21 p0132 A79-17424
- Flat plate collector - Experimental studies and design data for India 21 p0132 A79-17425
- Optimum tilt for the flat plate collector 21 p0132 A79-17426
- A contribution to evaluation of flat-plate solar collectors performance 21 p0133 A79-17427
- Availability of solar energy at Baghdad, Iraq - Performance and design data for flat plate collectors 21 p0133 A79-17428
- Liquid solar collector --- low cost assemblage with black water working fluid 21 p0133 A79-17433
- Evacuated solar flat-plate collectors for economic applications 21 p0133 A79-17435
- Construction and test of a test apparatus for determining the efficiency of solar collectors with the ASR-test method 21 p0134 A79-17436
- Theoretical and experimental yields of a solar heater with flat plate collectors 21 p0134 A79-17437
- Performance of optimal geometry three step compound wedge stationary concentrator --- solar collector using flat side mirrors 21 p0134 A79-17438
- A compound parabolic concentrator for a high temperature solar collector requiring only twelve tilt adjustments per year 21 p0134 A79-17439
- Compound parabolic concentrators with non-evacuated receivers - Prototype performance and a larger scale demonstration in a school heating system 21 p0134 A79-17440
- P.E.R.I.C.L.E.S. - Design of a stationary spherical collector --- solar energy application 21 p0134 A79-17441
- An analysis of a cylindrical parabolic focussing collector for distributed collector power system 21 p0134 A79-17442
- Geometrical aspects of a cylindrical parabolic collector 21 p0134 A79-17443
- Optimum design parameters of horizontal coaxial cylinders for a solar energy collector 21 p0134 A79-17444
- Development of solar collectors for low temperature level and of concentrators for thermal and photoelectric conversion 21 p0135 A79-17445
- A cost effective total energy system using a faceted mirror sunlight concentrator and high intensity solar cells 21 p0135 A79-17446
- Design fabrication and testing of three meter diameter parabolic dish heliostat system 21 p0135 A79-17447
- High temperature solar collector of optimal concentration - Non-focusing lens with secondary concentrator 21 p0135 A79-17448
- The USA SNW solar thermal test facility 21 p0135 A79-17449
- Receiver designs for tower-top solar collector 21 p0135 A79-17450
- Distribution of beam radiation of the receiver plane of a CPC solar concentrator --- Compound Parabolic Concentrators 21 p0135 A79-17451
- Large-aperture radiant solar energy concentrators 21 p0135 A79-17452
- Performance of solar concentrators - A theoretical study 21 p0135 A79-17453
- Solar concentrators --- using cheap refractive lenses 21 p0136 A79-17455
- Design, construction and performance of Fresnel lens for solar energy collection 21 p0136 A79-17456
- A simple solar tracking system --- manually adjusted rotating shaft for solar concentrator positioning 21 p0136 A79-17457
- The design and evaluation of a hydraulic-solar powered tracking device 21 p0136 A79-17458
- Manufacture of curved glass mirrors for linear concentrators 21 p0136 A79-17459
- Design of solar energy concentrators for power generation in residential and nonresidential areas 21 p0136 A79-17460
- Simulation and design of evacuated tubular solar residential air conditioning systems and comparison with actual performance 21 p0138 A79-17475
- Integration of evacuated tubular solar collectors with lithium bromide absorption cooling systems 21 p0139 A79-17483
- Dynamic response of a novel solar water heater --- collector using low-boiling liquid between flat plates 21 p0140 A79-17488
- Experimental investigation on solar house heating in northern India 21 p0140 A79-17495
- Preliminary results from the Georgia Tech 400 kWth Solar Thermal Test Facility 21 p0141 A79-17499
- Design and performance of 1/4 H.P. solar power unit 21 p0141 A79-17503
- Medium capacity heliothermal power stations 21 p0142 A79-17507

- The development of a 37 kW solar-powered irrigation system 21 p0144 A79-17525
- Laser ray trace tester for parabolic trough solar collectors 21 p0144 A79-17619
- The development of photovoltaic conversion systems with sunlight concentration 21 p0148 A79-17995
- Econometric analysis of concentrators for solar cells 21 p0149 A79-18017
- Optimal geometries for one- and two-faced symmetric side-wall booster mirrors --- for solar collectors 21 p0149 A79-18019
- Calculation of flat-plate collector utilizability 21 p0149 A79-18020
- Ideal prism solar concentrators 21 p0149 A79-18023
- The place of extreme asymmetrical non-focussing concentrators in solar energy utilization 21 p0149 A79-18024
- Shading and spacing in paraboloidal collector arrays 21 p0150 A79-18025
- Some aspects of the transient response of a flat-plate solar energy collector 21 p0153 A79-18466
- Gas-cycle solar refrigeration system performance 21 p0153 A79-18471
- Performance testing of solar collectors 21 p0155 A79-18875
- Limitations of solar assisted heat pump systems [ASME PAPER 78-WA/SOL-1] 21 p0162 A79-19834
- Numerical computation of the loss coefficients for evacuated cylindrical collector receiver tubes [ASME PAPER 78-WA/SOL-3] 21 p0162 A79-19836
- Efficiency degradation due to tracking errors for point focusing solar collectors [ASME PAPER 78-WA/SOL-4] 21 p0162 A79-19837
- Solar receiver performance of point focusing collector system [ASME PAPER 78-WA/SOL-5] 21 p0163 A79-19838
- 1MW calorimetric receiver for Solar Thermal Test Facility [ASME PAPER 78-WA/SOL-7] 21 p0163 A79-19839
- A theoretical analysis of solar collector/storage panels [ASME PAPER 78-WA/SOL-11] 21 p0163 A79-19843
- Solar collector storage panel [ASME PAPER 78-WA/SOL-12] 21 p0163 A79-19844
- On the optimisation of Trombe wall solar collectors [ASME PAPER 78-WA/SOL-13] 21 p0163 A79-19845
- Effect of physical properties of a flat plate solar collector cover on efficiency calculations - Simplifying hypotheses 21 p0164 A79-19949
- Composite heliostats of large solar plants 21 p0166 A79-20350
- Thermal deformations of solar-energy concentrators 21 p0166 A79-20355
- Solar-to-thermal energy converter based on coaxial evacuated tubular elements with multilayer and selective coatings 21 p0167 A79-20356
- Suitable optical materials for solar collector applications 22 p0239 A79-20823
- Analysis and design of a field of heliostats for a solar power plant 22 p0242 A79-21161
- Optimal distribution of heat conducting material in the finned pipe solar energy collector 22 p0242 A79-21163
- Computer based sun following system 22 p0242 A79-21165
- Augmented solar energy collection using different types of planar reflective surfaces - Theoretical calculations and experimental results 22 p0242 A79-21166
- Comparison of transient heat transfer models for flat plate collectors 22 p0242 A79-21168
- The application of thermography to large arrays of solar energy collectors 22 p0242 A79-21171
- Solar heating using a heat pump and cold collectors 22 p0254 A79-22268
- Solar thermal conversion installations in the medium power range - The Thek project 22 p0254 A79-22269
- Gold, silver, chromium, and copper cermet selective surfaces for evacuated solar collectors 22 p0256 A79-22855
- Efficiency of a series of thermoelectric generators in a solar wedge concentrator 22 p0260 A79-23618
- A comparison of compound parabolic and simple parabolic concentrating solar collectors 22 p0262 A79-23754
- Experiments with a flat plate solar water heating system in thermosyphonic flow 22 p0262 A79-23755
- Solar thermal electric power systems - Comparison of line-focus collectors 22 p0263 A79-23758
- Optimum collector slope for residential heating in adverse climates 22 p0263 A79-23761
- Flux-redistribution in the focal region of a planar Fresnel ring mirror --- solar furnace design 22 p0263 A79-23764
- The cryogenic heat transfer tunnel - A new tool for convective research --- thermal efficiency testing of solar tower receiver 22 p0267 A79-24316
- Effects of test fluid, flow rate, and flow regime on solar collector thermal performance measurements 22 p0268 A79-24317
- Selected ordinates for total solar radiant property evaluation from spectral data 22 p0271 A79-25060
- Radiant exchange for a fin and tube solar collector 22 p0271 A79-25066
- A test bed for thermosyphon solar air collectors [AIAA PAPER 79-0541] 22 p0274 A79-25860
- Performance of residential solar heating and cooling system with flat-plate and evacuated tubular collectors - CSU Solar House I 22 p0276 A79-25939
- Analysis and design of air heating unglazed flat plate solar collectors 22 p0280 A79-26202
- Heat transfer in a solar radiation absorbing fluid layer flowing over a substrate 22 p0281 A79-26204
- Natural convection heat transfer in small and moderate aspect ratio enclosures - An application to flat plate collectors 22 p0281 A79-26206
- Cavity-type surfaces for solar collectors 22 p0283 A79-26497
- Design considerations for residential solar heating and cooling systems utilizing evacuated tube solar collectors 22 p0285 A79-26815
- Efficient Fresnel lens for solar concentration 22 p0285 A79-26816
- Heat loss characteristics of an evacuated plate-in-tube collector 22 p0285 A79-26818
- Economic feasibility of solar water and space heating 22 p0292 A79-27899
- Optical coatings for a space laser communications system 22 p0292 A79-28028
- Optics applied to solar energy IV; Proceedings of the Seminar, San Diego, Calif., August 30, 31, 1978 22 p0293 A79-28140
- First-order design variables for concentrating solar collectors 22 p0293 A79-28141
- System designs for low cost-low ratio solar concentrators 22 p0293 A79-28142
- Linear echelon refractor/reflector solar concentrators 22 p0293 A79-28143
- A flat plate multiple pass solar collector using aqueous optical properties 22 p0293 A79-28144

# SUBJECT INDEX

# SOLAR COLLECTORS CONTD

A parabolic solar reflector for accurate and economic producibility 22 p0293 A79-28145

A comparison of solar thermal energy collection using fixed and tracking collectors 22 p0293 A79-28146

Specularity measurements for solar materials 22 p0294 A79-28153

Thermal analysis of black liquid cylindrical parabolic collector 22 p0295 A79-28354

Results and analysis of a round robin test program for liquid-heating flat-plate solar collectors 22 p0295 A79-28356

Effect of form errors on the characteristics of ellipsoidal radiant energy concentrators 22 p0296 A79-28667

Accelerated tests for coatings --- for solar concentrators 22 p0296 A79-28668

Controlling the radiant flux of a high-temperature solar energy conversion system over two parameters 22 p0296 A79-28669

Study of the spectral characteristics of metallized polymer films for production of solar concentrators 22 p0297 A79-28672

Symmetrical and asymmetrical ideal cylindrical radiation transformers and concentrators 22 p0303 A79-29647

Space solar power - An energy alternative 22 p0303 A79-29796

Regulation and control concepts for the possibilities of a utilization of solar energy in the low-temperature range 22 p0305 A79-30345

Design considerations of small solar collector systems using plane heliostats [ASME PAPER 79-SOL-2] 22 p0307 A79-30540

Ranking and evaluation of flat-plate collectors - Two new approaches --- for seasonal storage solar-heating systems 22 p0316 A79-31402

Optimization of the flow passage geometry for air heating solar collectors 22 p0316 A79-31403

Performance analysis of a flat-plate solar collector using 'forge-fin' tubes 22 p0316 A79-31404

Energy analysis of an aluminum solar collector 22 p0316 A79-31405

Dimensional relations for free convective heat transfer in flat-plate collectors --- solar collector heat loss 22 p0316 A79-31406

Thermal performance evaluation of a flat-plate cylindrical parabolic concentrator and a flat-plate collector 22 p0317 A79-31408

A solar collector thermal performance test for developmental programs 22 p0317 A79-31413

Report on a survey of operational solar systems 22 p0318 A79-31418

The performance of a site built, air heating, vertical collector with snow reflector in Quebec 22 p0319 A79-31423

New approaches for the appropriate use of solar energy in northern climates 22 p0319 A79-31424

A cost effective vertical air/water solar heating collector 22 p0320 A79-31430

Collector and storage efficiencies in solar heating systems 22 p0320 A79-31432

Solar heating and ventilation using the modified Trombe wall system 22 p0320 A79-31435

South wall solar collector with active collector system 22 p0320 A79-31436

Economic design of a solar domestic water heating system 22 p0321 A79-31438

Mathematical modelling of passive solar systems 22 p0321 A79-31441

The honeycomb heat trap - Its application in flat plate solar collectors 22 p0322 A79-31447

Cylindrical parabolic collector optimization for interfacing with steam turbine generators 22 p0322 A79-31448

The first year of solar collector testing at Ontario Research 22 p0322 A79-31450

Studies on solar collector performance at NRC 22 p0322 A79-31451

Alternate energy installations on the Jordan College Campus 22 p0323 A79-31454

Determination of the potential for solar retrofitting in Edmonton --- pilot systems for single family dwellings 22 p0323 A79-31456

Solar heating of domestic hot water at the Confederation Heights Cafeteria 22 p0323 A79-31457

P.E.I. solar assisted domestic water heat project 22 p0323 A79-31458

Alternative power-generation systems 21 p0169 A79-10129

Indoor test for thermal performance evaluation on the Northrup concentrating solar collector [NASA-CR-150804] 21 p0172 A79-10515

Thermal performance evaluation of the Calmac (liquid) solar collector [NASA-CR-150819] 21 p0173 A79-10521

Development of surfaces optically suitable for flat solar panels [NASA-CR-150831] 21 p0173 A79-10522

Design package for concentrating solar collector panels [NASA-CR-150788] 21 p0173 A79-10523

Status of the DOE photovoltaic concentrator technology development project [SAND-78-0948C] 21 p0176 A79-10550

Solar ponds. Citations from the NTIS data base [NTIS/PS-78/0836/3] 21 p0176 A79-10553

Solar ponds. Citations from the engineering index data base [NTIS/PS-78/0837/1] 21 p0176 A79-10554

Solar energy concentrator design and operation. Citations from the NTIS data base [NTIS/PS-78/0838/9] 21 p0178 A79-10566

Analytical methods for evaluating two-dimensional effects in flat-plate solar collectors 21 p0181 A79-11462

Thermal analysis of receivers for solar concentrators and optimization procedure for power production 21 p0182 A79-11465

Solar cells having integral collector grids [NASA-CASE-LEW-12819-1] 21 p0182 A79-11467

Method for making an aluminum or copper substrate panel for selective absorption of solar energy [NASA-CASE-MPS-23518-1] 21 p0182 A79-11469

Non-tracking solar energy collector system [NASA-CASE-WPO-13817-1] 21 p0182 A79-11471

Solar cell collector and method for producing same [NASA-CASE-LEW-12552-2] 21 p0182 A79-11472

Augmented solar energy collection using various planar reflective surfaces: Theoretical calculations and experimental results [LA-7041] 21 p0185 A79-11494

Sensitivity of slope measurements on parabolic solar mirrors to positioning and alignment of the laser scanner [SAND-78-0700] 21 p0185 A79-11496

Fixed mirror solar concentrator for power generation [GA-A-14883] 21 p0187 A79-11526

Methods for reducing heat losses from flat plate solar collectors, phase 2 [COO-2597-4] 21 p0188 A79-11533

MSFC hot air collectors [NASA-TM-78206] 21 p0196 A79-12556

Combined photovoltaic thermal collector testing [SAND-78-1191C] 21 p0198 A79-12570

Provisional flat plate solar collector testing procedures [PB-283721/9] 21 p0198 A79-12571

Long-term weathering effects on the thermal performance of the Lennox/Honeywell (liquid) solar collector [NASA-CR-150818] 21 p0204 A79-13493

## SOLAR CONSTANT

## SUBJECT INDEX

Libbey-Owens-Ford solar collector static load test  
[NASA-CR-150852] 21 p0205 N79-13494

Evaluation of high performance evacuated tubular  
collectors in a residential heating and cooling  
system: Colorado State University Solar House 1  
[COO-2577-14] 21 p0206 N79-13507

Design of low-cost structures for photovoltaic  
arrays. Task 1: Survey of array structural  
characteristics  
[SAND-78-7021] 21 p0206 N79-13509

Concentrating solar collector test results,  
Collector Module Test Facility  
[SAND-78-0815] 21 p0208 N79-13522

Optical design of a solar collector for the  
advanced solar thermal electric  
conversion/process heat program  
[Y/SUB-77/14261] 21 p0209 N79-13528

Solar evacuated tube collector: Absorption  
chiller systems simulation  
[COO-2577-13] 21 p0209 N79-13530

Flat plate solar collector design and performance.  
Citations from the NTIS data base  
[NTIS/PS-78/0840/5] 21 p0212 N79-13551

Concentrator enhanced solar arrays design study  
[NASA-CR-158032] 21 p0219 N79-14546

Solar thermal test facility experiment manual  
[SAND-77-1173] 21 p0221 N79-14568

Performance testing of the Hexcel Parabolic Trough  
Solar Collector  
[SAND-76-0381] 21 p0221 N79-14569

Recommendations for the conceptual design of the  
Barstov, California, solar central receiver  
pilot plant: Executive summary  
[SAND-77-8035] 21 p0221 N79-14571

Thermal performance evaluation of the Solargenics  
solar collector at outdoor conditions  
[NASA-CR-150857] 21 p0228 N79-15401

Design data brochure for the Owens-Illinois Sunpak  
(TM) air-cooled solar collector  
[NASA-CR-150868] 21 p0229 N79-15404

Qualification test and analysis report: Solar  
collectors  
[NASA-CR-150860] 22 p0333 N79-16360

Analysis and experimental tests of a  
high-performance evacuated tubular collector  
[NASA-CR-150874] 22 p0334 N79-16370

Long term weathering effects on the thermal  
performance of the sunworks (liquid) solar  
collector  
[NASA-CR-150899] 22 p0341 N79-17328

Preliminary design package for Sunair SEC-601  
solar collector  
[NASA-CR-150875] 22 p0341 N79-17332

Development, testing, and certification of Calmac  
Mfg. Corp. solar collector and solar operated pump  
[NASA-TM-78218] 22 p0342 N79-17338

An improved solar panel and method for fabricating  
the same  
[NASA-CASE-WFO-14490-1] 22 p0348 N79-18445

Thermal performance evaluation of MSFC hot air  
collectors with various flow channel depth  
[NASA-CR-150900] 22 p0348 N79-18449

Long-term weathering effects on the thermal  
performance of the Libbey-Owens-Ford (liquid)  
solar collector  
[NASA-CR-161093] 22 p0348 N79-18450

Solar water heating  
[BMPT-FB-T-77-42] 22 p0349 N79-18457

Proposal for a representation of the  
quasisteady-state performance of flat-plate  
collectors  
[ASSA-SE-821/77] 22 p0349 N79-18461

Optical coatings for solar cells and solar  
collectors. Citations from the NTIS data base  
[NTIS/PS-78/1341/3] 22 p0350 N79-18465

Optical coatings for solar cells and solar  
collectors. Citations from the Engineering  
index data base  
[NTIS/PS-78/1342/1] 22 p0350 N79-18466

A two-dimensional thermal analysis of a new  
high-performance tubular solar collector  
22 p0352 N79-19060

Electromagnetic radiation energy arrangement ---  
coatings for solar energy absorption and  
infrared reflection  
[NASA-CASE-WOO-00428-1] 22 p0352 N79-19186

A fixed tilt solar collector employing reversible  
vee-through reflectors and evaluated tube  
receivers for solar heating and cooling systems  
[NASA-CR-158420] 22 p0359 N79-20490

The parabolic concentrating collector: A tutorial  
[NASA-CR-158246] 22 p0359 N79-20491

Performance characteristics of a 1.8 by 3.7 meter  
Fresnel lens solar concentrator  
[NASA-TM-78222] 22 p0360 N79-20495

An improved solar energy receiver for a stirling  
engine  
[NASA-CASE-WFO-14619-1] 22 p0362 N79-20513

An analytical investigation of the performance of  
solar collectors as nighttime heat radiators in  
airconditioning cycles  
[NASA-CR-3111] 22 p0363 N79-20519

Laboratories technically qualified to test solar  
collectors in accordance with ASHRAE standard  
93-77: A summary report  
[PB-289729/6] 22 p0363 N79-20524

Solar space heaters for low-income families  
[PB-289244/6] 22 p0363 N79-20526

A low cost high temperature sun tracking solar  
energy collector  
22 p0366 N79-21390

Development, testing, and certification of the  
Northrup, Inc., NL series concentrating solar  
collector model NSC-01-0732  
[NASA-TM-78219] 22 p0371 N79-21618

Design package for programmable controller and  
hydraulic subsystem  
[NASA-CR-161151] 22 p0371 N79-21619

Development, testing, and certification of  
Owens-Illinois model SEC-601 solar energy  
collector system  
[NASA-TM-78223] 22 p0371 N79-21620

Long term weathering effects on the thermal  
performance of the solaron (air) solar collector  
[NASA-CR-161166] 22 p0371 N79-21621

Experimental verification of a standard test  
procedure for solar collectors  
[PB-289912/8] 22 p0372 N79-21632

**SOLAR CONSTANT**  
Total solar irradiance at Table Mtn, California  
1926-77  
21 p0067 A79-14269

**SOLAR COOLING**  
Can solar energy contribute significantly to the  
solution of the world's energy famine  
21 p0019 A79-10155

Analysis and design of an 18-ton solar-powered  
heating and cooling system  
21 p0019 A79-10156

Liquid desiccant solar air conditioner and energy  
storage system  
21 p0021 A79-10176

The fossil fuel cost of solar heating  
21 p0022 A79-10180

Passive solar heating and cooling  
[AIAA PAPER 78-1756] 21 p0060 A79-13857

Performance testing of a three ton solar  
absorption chiller  
[AIAA PAPER 78-1757] 21 p0060 A79-13858

Evaluation of control options for solar climate  
control systems  
[AIAA PAPER 78-1758] 21 p0060 A79-13859

The ClearView Solar Collector system and  
associated one and two stage evaporative cooling  
- Interim results  
[AIAA PAPER 78-1759] 21 p0061 A79-13860

Metal hydride solar heat pump and power system  
/HYCSOS/  
[AIAA PAPER 78-1762] 21 p0061 A79-13863

Barriers and incentives to the commercialization  
of solar heating and cooling of buildings  
21 p0072 A79-14687

Passive solar design --- for domestic heating and  
cooling systems  
21 p0074 A79-14720

Conference on Performance Monitoring Techniques  
for Evaluation of Solar Heating and Cooling  
Systems, Washington, D.C., April 3, 4, 1978,  
Proceedings  
21 p0087 A79-15826

Analysis of data user's needs for performance  
evaluation of solar heating and  
cooling systems  
21 p0087 A79-15827

- Technique and instrumentation for measuring the performance of integrated solar heating/cooling systems 21 p0087 A79-15830
- The use of computer-controlled data acquisition systems in determining solar heating and cooling system performance 21 p0088 A79-15834
- Flow rate calibration for solar heating and cooling system evaluation 21 p0089 A79-15845
- Temperature calibration for solar heating and cooling system evaluation 21 p0089 A79-15846
- Solar absorption cooling 21 p0090 A79-15861
- Solar total energy systems 21 p0090 A79-15863
- Residential and commercial thermal storage --- for solar heating and cooling systems 21 p0090 A79-15865
- An overview of solar markets 21 p0092 A79-15884
- Solar heating and cooling - An electric utility perspective 21 p0093 A79-15890
- The Solar Heating and Cooling Commercial Demonstration Program at Marshall Space Flight Center - Some problems and conclusions 21 p0099 A79-16135
- Solar controls and control modifications - New century town solar homes, Vernon Hills, IL 21 p0102 A79-16419
- Using controls to reduce component size and energy needs for solar HVAC --- Heating Ventilation, Air Conditioning 21 p0102 A79-16421
- The El Camino Real Solar Cooling Demonstration Project 21 p0102 A79-16425
- Principles of solar cooling and heating 21 p0103 A79-16457
- Solar heating and ventilating by natural means 21 p0103 A79-16458
- Application of solar cooling for a school building in subtropics 21 p0103 A79-16461
- A microprocessor-based control system for solar heating and cooling 21 p0107 A79-16565
- The economics of solar heating and cooling - A cautious view 21 p0119 A79-17297
- Thermal performance of solar collectors used in the national solar heating and cooling demonstration program 21 p0130 A79-17403
- A channelled solar flat-plate booster --- reflector-absorber system for optimum collector insolation 21 p0131 A79-17413
- Design and optimization of a flat plate collector for cooling application 21 p0132 A79-17419
- Optimising the pitching of tubes in a flat solar collector for increasing the efficiency for use in vapour absorption refrigeration 21 p0132 A79-17422
- Availability of solar energy at Baghdad, Iraq - Performance and design data for flat plate collectors 21 p0133 A79-17428
- Analysis and design of solar buildings using the Cal-ERDA computer programs 21 p0137 A79-17463
- Experiments in solar space heating and cooling for moderately insulated regions 21 p0137 A79-17464
- Stochastic simulation experiments on solar air conditioning systems 21 p0138 A79-17474
- Simulation and design of evacuated tubular solar residential air conditioning systems and comparison with actual performance 21 p0138 A79-17475
- Optimizing solar energy systems using continuous flow control 21 p0138 A79-17477
- Performance of solar heating and cooling systems used in the national solar heating and cooling demonstration program 21 p0139 A79-17478
- Theoretical basis and design for a residential size solar powered ammonia/water absorption air conditioning system 21 p0139 A79-17479
- A solar heating and cooling system for an industrial plant located in southern Europe 21 p0139 A79-17480
- An experimental evaluation of an intermittent cycle solar-powered ammonia/water absorption air conditioning system 21 p0139 A79-17481
- Performance predictions of a LiBr absorption air conditioner utilizing solar energy 21 p0139 A79-17482
- Integration of evacuated tubular solar collectors with lithium bromide absorption cooling systems 21 p0139 A79-17483
- Solar ammonia-water absorption system for cold storage application 21 p0143 A79-17521
- Design of a solar energy operated lithium-bromide water absorption refrigeration system for refrigeration storage 21 p0143 A79-17523
- Solar energy --- conversion technologies 21 p0147 A79-17648
- Gas-cycle solar refrigeration system performance 21 p0153 A79-18471
- Cooling applications of thermic diode panels [ASHE PAPER 78-WA/SOL-10] 21 p0163 A79-19842
- Design of a freon jet pump for use in a solar cooling system [ASHE PAPER 78-WA/SOL-15] 21 p0164 A79-19847
- Stochastic predictions of solar cooling system performance [ASHE PAPER 78-WA/SOL-16] 21 p0164 A79-19848
- Buoyancy effects in a solar regenerator --- for air dehumidifier absorbent solutions 22 p0262 A79-23752
- System performance predictions for solar cooling using regional stochastic weather models 22 p0264 A79-23781
- The effects of internal latent energy storage on the operational dynamics of a solar-powered absorption cycle 22 p0267 A79-24311
- A computer simulation model for determining preferred solar heating and cooling systems 22 p0267 A79-24313
- International Solar Energy Conference on the Performance of Solar Heating and Cooling Systems, Dusseldorf, West Germany, April 19, 20, 1978, Proceedings 22 p0275 A79-25926
- Prospects for solar heating and cooling in the United States 22 p0275 A79-25929
- Solar heating, cooling and hot water production - A critical look at CCMS installations 22 p0275 A79-25931
- Solar air heating and nocturnal cooling system /CSU Solar House II/ 22 p0275 A79-25932
- Performance of residential solar heating and cooling system with flat-plate and evacuated tubular collectors - CSU Solar House I 22 p0276 A79-25939
- Solar heating and cooling performance of the Los Alamos National Security and Resources Study Center 22 p0277 A79-25944
- Design considerations for residential solar heating and cooling systems utilizing evacuated tube solar collectors 22 p0285 A79-26815
- Performance of combined solar-heat pump systems 22 p0285 A79-26817
- Design and optimisation of an absorption refrigeration system operated by solar energy 22 p0285 A79-26819
- Solar energy application of natural zeolites --- solid absorber-water vapor working fluid system for sorption-refrigeration cycles 22 p0286 A79-27213

# SOLAR ELECTRIC PROPULSION

# SUBJECT INDEX

Solar absorption cooling feasibility 22 p0295 A79-28358

Production and application of rolling-welded aluminum alloy panels for solar water heaters for hot water and cooling systems 22 p0297 A79-28670

Passive solar energy design and materials --- Book 22 p0302 A79-29625

Solar Rankine engines - Examples and projected costs [ASME PAPER 79-SOL-3] 22 p0307 A79-30541

Heat pump design - Cost effectiveness in the collection, storage and distribution of solar energy 22 p0313 A79-31316

Distributed energy storage for solar applications 22 p0317 A79-31410

Design study on solar energy systems for commercial buildings 22 p0320 A79-31433

Solar energy - Four sites demonstrate potential 22 p0328 A79-32194

Solar heating and cooling system design and development [NASA-CR-150803] 21 p0172 A79-10516

Solar heating and cooling demonstration project summaries [DOE/CS-0009] 21 p0186 A79-11503

Prototype solar heating and cooling systems [NASA-CR-150828] 21 p0196 A79-12552

Instrumentation at the Decade 80 solar house in Tucson, Arizona [NASA-CR-150851] 21 p0204 A79-13491

Evaluation of high performance evacuated tubular collectors in a residential heating and cooling system: Colorado State University Solar House 1 [COO-2577-14] 21 p0206 A79-13507

Solar heating and cooling. Research and development: Project summaries [DOE/CS-0010] 21 p0208 A79-13519

Legal barriers to solar heating and cooling of buildings [BCP/M2528-1] 21 p0209 A79-13534

Candidate chemical systems for air cooled, solar powered, absorption air conditioner design. Part 2: Solid absorbents, high latent heat refrigerants [SAM/1587-2] 21 p0211 A79-13544

System integration of marketable subsystems --- for residential solar heating and cooling [NASA-CR-161104] 22 p0348 A79-18448

Solar building regulatory study, volume 2 [PB-289824/5] 22 p0357 A79-20291

Cost analysis and optimization study for solar heating and cooling systems, Stillwater, Minnesota and Newcastle, Pennsylvania [NASA-CR-161201] 22 p0358 A79-20478

Cost analysis and optimization study for solar heating and cooling systems [NASA-CR-161200] 22 p0360 A79-20499

Design of solar heating and cooling systems [AD-A062719] 22 p0363 A79-20522

Solar energy pilot study [PB-289380/8] 22 p0363 A79-20525

Solar building regulatory study, volume 1 [PB-289823/7] 22 p0365 A79-21235

Interim performance criteria for solar heating and cooling systems in residential buildings, second edition [PB-289967/2] 22 p0372 A79-21630

Report of the 4th CCMS (Committee on the Challenges of Modern Society) Solar Energy Pilot Study Meeting [PB-289492/1] 22 p0372 A79-21631

**SOLAR ELECTRIC PROPULSION**

Status of wraparound contact solar cells and arrays --- for spacecraft electric propulsion 21 p0001 A79-10014

Earth orbital assessment of solar electric and solar sail propulsion systems [NASA-CR-158167] 22 p0345 A79-17898

Closed Loop solar array-ion thruster system with power control circuitry [NASA-CASE-LEW-12780-1] 22 p0357 A79-20179

**SOLAR ENERGY**

A new power cycle that combines power generation with energy storage 21 p0004 A79-10040

Recent advances in thermochemical energy storage and transport 21 p0012 A79-10104

Storage systems for solar thermal power 21 p0013 A79-10108

Can solar energy contribute significantly to the solution of the world's energy famine 21 p0019 A79-10155

Solar energy and the 'Common Heritage of Mankind' --- international agreements regarding usage [IAF PAPER 78-SL-45] 21 p0035 A79-11356

Theoretical upper limit to the conversion efficiency of solar energy 21 p0042 A79-11876

Annual available radiation for fixed and tracking collectors 21 p0042 A79-11880

Solar thermal energy storage using heat of dilution - Analysis of heat generation in multistage mixing column 21 p0046 A79-12271

German Solar Energy Forum, 1st, Hamburg, West Germany, September 26-28, 1977, Proceedings. Volume 2 21 p0055 A79-13619

Potential and technical utilization of renewable energy sources 21 p0058 A79-13655

Vehicle operation on fuels from solar energy 21 p0059 A79-13663

Saudi Arabia looks at the sun 21 p0063 A79-13900

Alternative energy for domestic hot water - Wind or solar 21 p0067 A79-14292

A systems study of our energy problems 21 p0074 A79-14704

Solar energy - Past and present developments 21 p0076 A79-14764

Collection of data for estimating the probable life cycle costs of solar energy systems 21 p0087 A79-15828

Considerations in choosing solar energy monitoring systems 21 p0087 A79-15831

Materials problems in solar, nuclear and storage of energy 21 p0094 A79-15901

International Symposium-Workshop on Solar Energy, Cairo, Egypt, June 16-22, 1978, Symposium Lectures 21 p0102 A79-16451

Possibilities for solar energy utilization in Egypt 21 p0102 A79-16453

The economics and policy of alternative energy sources - A review 21 p0103 A79-16454

Thermal storage of solar energy 21 p0103 A79-16459

Integrated solar building systems 21 p0103 A79-16460

Solar-hydrogen energy system and solar-hydrogen production methods 21 p0104 A79-16463

Solar hydrogen production at high temperatures 21 p0104 A79-16464

Sun: Mankind's future source of energy: Proceedings of the International Solar Energy Congress, New Delhi, India, January 16-21, 1978. Volumes 1, 2 & 3 21 p0116 A79-17276

Analysis of alternatives for U.S. international cooperation in solar energy 21 p0116 A79-17277

The solar energy R & D programme of the European Communities 21 p0116 A79-17278

Solar energy in Latin America - An overview 21 p0116 A79-17279

Solar energy R&D in Iran - The approach and the philosophy 21 p0117 A79-17284

Solar energy in Southern Africa 21 p0117 A79-17287

Costs and impacts of financial incentives for solar energy systems 21 p0119 A79-17296

Long-term storage of solar energy in native rock 21 p0120 A79-17314

# SUBJECT INDEX

# SOLAR ENERGY ABSORBERS

- Energy through solar aided bio-gas systems 21 p0125 A79-17367
- Conceptual development of a solar town in Iran 21 p0138 A79-17469
- Hourly vs daily method of computing insolation on inclined surfaces 22 p0242 A79-21164
- Diffuse solar radiation on a horizontal surface for a clear sky 22 p0242 A79-21167
- Energy storage using the reversible oxidation of barium oxide 22 p0242 A79-21169
- International Conference on Thermoelectric Energy Conversion, 2nd, University of Texas, Arlington, Tex., March 22-24, 1978, Proceedings and Supplement 22 p0259 A79-23603
- Solar energy storage as hydrogen and bromine from hydrogen bromide 22 p0265 A79-24045
- Energy conversion engineering --- Book 22 p0302 A79-29575
- The potential for solar energy development 22 p0304 A79-30172
- System for projecting the utilization of renewable resources. SPURR methodology [ERRQ/2322-77/4] 21 p0174 A79-10538
- Solar powered irrigation: Present status and future outlook [SAND-78-0016C] 21 p0175 A79-10539
- Solid desiccant air conditioning with silica gel using solar energy 21 p0181 A79-11464
- Method for making an aluminum or copper substrate panel for selective absorption of solar energy [NASA-CASE-HPS-23518-1] 21 p0182 A79-11469
- Program THER energy production units of average power and using thermal conversion of solar radiation [NASA-TM-75369] 21 p0183 A79-11474
- Optimum dry-cooling sub-systems for a solar air conditioner [NASA-TM-79007] 21 p0183 A79-11477
- Environmental Development Plan (EDP): Solar thermal power systems, 1977 [DOE/EDP-0004] 21 p0187 A79-11522
- Plan for the development and implementation of standards for solar heating and cooling applications [PB-283237/6] 21 p0190 A79-11543
- Application of solar technology to today's energy needs, volume 1 [PB-283770/6] 21 p0190 A79-11548
- Characterization of solar cells for space applications. Volume 4: Electrical characteristics of Spectrolab ESP 200-micron Helios cells as a function of intensity and temperature [NASA-CR-157934] 21 p0195 A79-12543
- Solar Total Energy Test Facility project test results: High-temperature thermocline storage subsystem [SAND-77-1528] 21 p0197 A79-12565
- Prototype solar heating and cooling systems including potable hot water [NASA-CR-150850] 21 p0205 A79-13498
- LARGO hot water system thermal performance test report [NASA-CR-150841] 21 p0205 A79-13500
- Solar assisted heat pump study for heating of military facilities [AD-A058626] 21 p0206 A79-13506
- Solar Irrigation Program Data Base Management System (SIPDBMS) [SAND-78-0641] 21 p0209 A79-13532
- Solar energy [DOE/ET-0062] 21 p0210 A79-13535
- Solar irrigation program [SAND-78-0049] 21 p0210 A79-13537
- Analysis of federal incentives used to stimulate energy production [PNL-2410] 21 p0210 A79-13539
- Solar pilot plant, phase 1 [SAR/1109-77-7] 21 p0210 A79-13542
- Solar energy, water, and industrial systems in arid lands: Technological overview and annotated bibliography [PB-285129/3] 21 p0211 A79-13549
- Solar electric power generation, volume 2. Citations from the Engineering Index data base [HTIS/PS-78/1109/4] 21 p0212 A79-13558
- Primary reflector for solar energy collection systems [NASA-CASE-NPO-13579-4] 21 p0217 A79-14529
- Solar thermal test facility experiment manual [SAND-77-1173] 21 p0221 A79-14568
- Solar hot water system installed at Anderson, South Carolina [NASA-CR-150856] 21 p0229 A79-15405
- Use of solar energy to heat anaerobic digesters. Part 1: Technical and economic feasibility study. Part 2: Economic feasibility throughout the United States [PB-286940/2] 21 p0231 A79-15440
- Parameter estimation and validation of a solar assisted heat pump model 22 p0332 A79-16349
- Low-temperature application of solar energy in South Africa 22 p0340 A79-17324
- Fluidized-bed combustion 22 p0347 A79-18365
- Installation package for a solar heating system [NASA-CR-150876] 22 p0349 A79-18454
- Public hearing transcript: Federal non-nuclear energy research and development program [PB-287910/4] 22 p0349 A79-18464
- Thermal power systems point-focusing distributed receiver technology project. Volume 1: Executive summary [NASA-CR-158421] 22 p0360 A79-20492
- SOLAR ENERGY ABSORBERS
- Effect of surface curvature on measurement of the absorptance properties of solar coatings 21 p0042 A79-11879
- Nonimaging solar concentrators 21 p0043 A79-11973
- Selective coatings for aluminum and steel solar absorbers 21 p0058 A79-13647
- Solaronyx - Selective coating for solar energy absorbers 21 p0058 A79-13648
- Performance testing of a three ton solar absorption chiller [ATAA PAPER 78-1757] 21 p0060 A79-13858
- The ClearView Solar Collector system and associated one and two stage evaporative cooling - Interim results [ATAA PAPER 78-1759] 21 p0061 A79-13860
- External single pass to superheat receiver --- for central receiver solar power plant [ATAA PAPER 78-1751] 21 p0089 A79-15849
- Solar absorption cooling 21 p0090 A79-15861
- A new amorphous silicon-based alloy for electronic applications 21 p0100 A79-16226
- A graphical approach to the efficiency of flat-plate collectors 21 p0102 A79-16422
- MHD conversion of solar energy --- space electric power system 21 p0109 A79-16614
- Magnetically confined plasma solar collector --- satellite based system in space 21 p0109 A79-16617
- Theoretical and experimental analysis of a latent heat storage system --- solar energy absorbers 21 p0121 A79-17323
- Status report on selective surfaces --- solar collector absorbers 21 p0126 A79-17374
- Investigation and perspectives on iron oxide, zinc conversion coating, zinc oxide, cobalt oxide and tungsten oxide as spectral selective solar absorber surfaces 21 p0126 A79-17375
- DC reactively sputtered metal carbide and metal silicide selective absorbing surfaces --- for photothermal solar energy conversion 21 p0126 A79-17377
- Studies on the selective absorption surface on stainless steel --- for flat type solar collectors 21 p0127 A79-17378

## SOLAR ENERGY CONVERSION

## SUBJECT INDEX

- New processes for black coatings useful in harnessing solar energy. I - A room temperature black chromium plating bath 21 p0127 A79-17379
- Preparation and properties of pure and tin doped indium oxide selective coatings 21 p0127 A79-17381
- Selective absorption of solar energy by ultrafine metal particles 21 p0127 A79-17382
- Spectral selective properties of black chrome and nickel electrodeposited coatings for solar absorber 21 p0127 A79-17383
- Cheap packed bed absorbers for solar air heaters 21 p0128 A79-17388
- Reflecting horizontal collector 21 p0128 A79-17395
- Convective effects in 'slat collectors' 21 p0129 A79-17400
- Proposal for efficient appreciation of solar thermal absorptive materials by high irradiance solar simulator 21 p0130 A79-17406
- Optimal profile of solar energy collectors 21 p0130 A79-17408
- The testing procedures of thermal performance of solar collector at Solar Research Lab., G.I.R.I. 21 p0130 A79-17409
- Field performance of certain selective and neutral surfaces in solar collectors 21 p0131 A79-17417
- Solar collector optimization 21 p0132 A79-17418
- Comparative performance of tracking type and non-tracking type solar collectors 21 p0136 A79-17454
- Design and performance of 1/4 H.P. solar power unit 21 p0141 A79-17503
- Suitable optical materials for solar collector applications 22 p0239 A79-20823
- The dependence of optical properties on the structural composition of solar absorbers - Gold black 22 p0242 A79-21162
- Gold, silver, chromium, and copper cermet selective surfaces for evacuated solar collectors 22 p0256 A79-22855
- Microstructure dependence of the optical properties of solar-absorbing black chrome 22 p0256 A79-22858
- Study of solid-gas-suspensions used for direct absorption of concentrated solar radiation 22 p0262 A79-23757
- Selective absorption of solar energy in ultrafine metal particles - Model calculations 22 p0273 A79-25746
- Heat transfer in a solar radiation absorbing fluid layer flowing over a substrate 22 p0281 A79-26204
- Optics applied to solar energy IV; Proceedings of the Seminar, San Diego, Calif., August 30, 31, 1978 22 p0293 A79-28140
- Microstructural characterization of a black chrome solar selective absorber 22 p0294 A79-28151
- Solar absorption cooling feasibility 22 p0295 A79-28358
- Energy analysis of an aluminum solar collector 22 p0316 A79-31405
- Optimization studies on black chrome electroplating variables for solar selective surfaces 22 p0317 A79-31407
- Selective-black absorbers using sputtered cermet films 22 p0327 A79-31969
- Black germanium solar selective absorber surfaces 22 p0327 A79-31970
- Electromagnetic radiation energy arrangement --- coatings for solar energy absorption and infrared reflection [NASA-CASE-800-00428-1] 22 p0352 A79-19186
- SOLAR ENERGY CONVERSION**
- Design features of the TDRSS solar array --- Tracking and Data Relay Satellites 21 p0002 A79-10019
- Evolution of satellite power system /SPS/ concepts 21 p0002 A79-10023
- The design and evaluation of a 5 GW GaAs solar power satellite /SPS/ 21 p0002 A79-10024
- Preliminary design of the solar total energy-large scale experiment at Shenandoah, Georgia 21 p0019 A79-10159
- Conceptual design of the Fort Hood Solar Total Energy-Large Scale Experiment 21 p0019 A79-10160
- Enhanced solar energy options using earth-orbiting mirrors 21 p0019 A79-10162
- Compartmental model for agricultural conversion of solar energy into fixed biomass 21 p0022 A79-10181
- Nitinol heat engines for economical conversion of low grade thermal density 21 p0027 A79-10230
- Economic methodology for solar power-generating systems 21 p0030 A79-10251
- Application of composite materials in the solar energy domain 21 p0034 A79-11195
- Semiconductor electrodes for conversion and storage of solar energy 21 p0036 A79-11777
- Role of semiconductor properties in photoelectrolysis 21 p0037 A79-11780
- Iron oxide semiconductor electrodes in photoassisted electrolysis of water 21 p0037 A79-11781
- Polycrystalline CdSe-based photo-electrochemical cells 21 p0037 A79-11785
- Hydrogen production in a solar-hydrogen economy 21 p0037 A79-11796
- Perspectives on utility central station photovoltaic applications 21 p0041 A79-11873
- Optics applied to solar energy conversion; Proceedings of the Seminar, San Diego, Calif., August 23, 24, 1977 21 p0042 A79-11965
- Photovoltaic effects in II-VI heterojunctions 21 p0042 A79-11967
- Options for solar thermal conversion 21 p0043 A79-11969
- Five MW solar thermal test facility heliostat focus and alignment system 21 p0043 A79-11972
- Nonimaging solar concentrators 21 p0043 A79-11973
- Predicted performance of heliostats for ERDA's 10 MWe power plant 21 p0044 A79-12045
- Analysis of a direct coupling d.c. motor and a photovoltaic converter 21 p0046 A79-12272
- Selling solar energy as a cash crop 21 p0049 A79-12725
- Study of diffusion processes in low-temperature thermopiles --- for solar energy conversion 21 p0054 A79-13290
- Rate of desorption in a solar regenerator 21 p0055 A79-13611
- Practical applications of silicon solar cells in appliances and installations 21 p0057 A79-13638
- Solar electric power supplies - Design and layout 21 p0057 A79-13639
- Solaronyx - Selective coating for solar energy absorbers 21 p0058 A79-13648
- Problems, status, and prospects of a solar hydrogen economy 21 p0059 A79-13658
- On the thermal and thermo-electrolytical generation of hydrogen by solar energy 21 p0059 A79-13660
- Solar One - A 10-megawatt solar thermal central receiver pilot plant project [AIAA PAPER 78-1750] 21 p0060 A79-13853
- Dynamic computer simulation of the DOE 10 MW solar thermal pilot plant [AIAA PAPER 78-1752] 21 p0060 A79-13854



## SUBJECT INDEX

## SOLAR ENERGY CONVERSION CONTD

- Alternative central receiver solar power plant  
using salt as a heat transfer and storage medium  
[AIAA PAPER 78-1753] 21 p0060 A79-13855
- Photovoltaic overview  
[AIAA PAPER 78-1763] 21 p0061 A79-13864
- Venture analysis of a proposed federal  
photovoltaic eight-year procurement plan  
[AIAA PAPER 78-1766] 21 p0061 A79-13865
- Pennies a day - Financing early deployment of  
photovoltaic utility applications through a user  
subsidy  
[AIAA PAPER 78-1767] 21 p0061 A79-13866
- NASA Lewis Research Center photovoltaic  
application experiments  
[AIAA PAPER 78-1768] 21 p0061 A79-13867
- Dispersed power systems and total energy --- solar  
energy conversion for combined  
mechanical/electrical and thermal loads  
[AIAA PAPER 78-1770] 21 p0062 A79-13868
- Future solar total energy markets for the U.S.  
industrial sector  
[AIAA PAPER 78-1773] 21 p0062 A79-13870
- Preliminary design of solar total energy - Large  
scale experiment at Shenandoah, Georgia  
[AIAA PAPER 78-1776] 21 p0062 A79-13873
- A hybrid thermochemical hydrogen production cycle  
using solar energy process heat  
[AIAA PAPER 78-1779] 21 p0062 A79-13874
- Electricity from sunlight --- low cost silicon for  
solar cells 21 p0065 A79-14116
- Effects of weather and pollution on incident solar  
energy - Basic measurements leading to computer  
models 21 p0065 A79-14117
- Performance of a tilted solar cell under various  
atmospheric conditions 21 p0066 A79-14261
- Simulations of the performance of open cycle  
desiccant systems using solar energy 21 p0066 A79-14262
- The photogalvanovoltaic cell 21 p0066 A79-14264
- Solar water pumping 21 p0066 A79-14266
- The National Program for Solar Energy 21 p0072 A79-14688
- Passive solar design --- for domestic heating and  
cooling systems 21 p0074 A79-14720
- Results of a tilt-tilt low profile heliostat test  
program 21 p0076 A79-14761
- Historical developments of the use of solar energy  
for pumping irrigation water 21 p0076 A79-14762
- Basic technical and economical aspects of the use  
of solar energy for pumping irrigation water 21 p0076 A79-14763
- The circumsolar measurement program - Assessment  
of the effects of atmospheric scattering on  
solar energy conversion 21 p0082 A79-15077
- History of solar energy applications - Solar  
energy yesterday, today and tomorrow 21 p0089 A79-15852
- Practical considerations for 'capturing the sun'  
21 p0089 A79-15853
- Solar energy and the flat plate collector - An  
annotated bibliography 21 p0090 A79-15858
- Design of active solar heating systems 21 p0090 A79-15860
- Solar total energy systems 21 p0090 A79-15863
- A central receiver solar thermal power system  
21 p0091 A79-15872
- Simple procedure for predicting long term average  
performance of nontracking and of tracking solar  
collectors 21 p0091 A79-15873
- An overview of solar markets 21 p0092 A79-15884
- Large-scale thermal energy storage for  
cogeneration and solar systems --- in aquifers  
21 p0092 A79-15886
- Factors influencing solar energy  
commercialization 21 p0093 A79-15897
- Biomimetic approach to solar energy conversion -  
Artificial photosynthesis 21 p0094 A79-15899
- Solar engines - The thermal wheel and beyond  
21 p0095 A79-15909
- Petroleum plantations --- hydrocarbon fuels from  
artificial photosynthesis and plants 21 p0095 A79-15910
- Materials and economics of energy systems  
21 p0095 A79-15911
- Net energy analysis and environmental aspects for  
solar tower central receiver systems. I -  
Methodology 21 p0097 A79-16101
- Space Congress, 15th, Cocoa Beach, Fla., April  
26-28, 1978, Proceedings 21 p0099 A79-16126
- An economist looks at solar energy - The  
government's role 21 p0099 A79-16132
- Current solar applications and economics  
21 p0099 A79-16134
- American Society of Heating, Refrigerating and  
Air-Conditioning Engineers, Annual Meeting,  
Albuquerque, N. Mex., June 25-29, 1978,  
Technical and Symposium Papers 21 p0101 A79-16415
- The use and limitations of ASHRAE solar algorithms  
in solar energy utilization studies 21 p0101 A79-16416
- Solar thermal conversion 21 p0104 A79-16466
- Solar electricity production 21 p0104 A79-16467
- Use of satellites in solar applications --- for  
insolation mapping and space power stations  
21 p0104 A79-16468
- Solar pumping --- thermal and electrical water  
pumping 21 p0104 A79-16469
- Analysis of optical behavior and collector  
performance of a solar concentrator 21 p0107 A79-16545
- The solar power satellite concept evaluation program  
21 p0107 A79-16602
- Orbiting mirrors for terrestrial energy supply  
21 p0108 A79-16605
- Energy conversion at a lunar polar site  
21 p0108 A79-16607
- Ultralightweight structures for space power ---  
solar energy collection for transmission to earth  
21 p0108 A79-16609
- Absorption of solar radiation by alkali vapors ---  
for efficient high temperature energy converters  
21 p0108 A79-16612
- New candidate lasers for power beaming and  
discussion of their applications --- solar  
powered space lasers 21 p0110 A79-16622
- Methods for the photochemical utilization of solar  
energy 21 p0111 A79-16641
- Factors affecting market initiation of solar total  
energy 21 p0112 A79-16732
- The status of solar energy --- for domestic water  
heating and thermal electric power generation  
21 p0115 A79-17219
- Report on the development of solar energy in France  
21 p0117 A79-17280
- The accomplishments of the United States Federal  
Solar Energy Program 21 p0117 A79-17281
- Solar energy research, development and  
demonstration program in Kuwait 21 p0117 A79-17282
- Solar energy activities in Austria 21 p0117 A79-17283
- Plans and prospects for solar energy utilisation  
in Malawi 21 p0117 A79-17285
- Estimation of collector and electrical energy cost  
for STEPS in Japan --- Solar Thermal Electric  
Power System 21 p0118 A79-17288
- Solar electrification and rural electrification -  
A techno-economic review 21 p0118 A79-17289

- Cost of solar energy 21 p0118 A79-17291
- Solar energy and the second law of thermodynamics 21 p0118 A79-17292
- The relationship between diffuse and total solar radiation in computer simulation of solar energy systems 21 p0119 A79-17304
- Measurement of solar radiation for energy conversion 21 p0119 A79-17305
- Chemically driven heat pumps for solar thermal storage 21 p0120 A79-17316
- Underground aquifer storage of hot water from solar energy collectors 21 p0120 A79-17317
- Phase change thermal storage for a solar total energy system 21 p0120 A79-17321
- A passive integrated unit for the collection, thermal storage in fusion materials and distribution of solar energy for home heating and other applications 21 p0121 A79-17322
- A thermal storage analysis on packed bed of alumina spheres --- in solar houses 21 p0121 A79-17324
- Use of monolithic structures for the short term storage of solar energy 21 p0121 A79-17327
- Mechanical energy storage system for a 10 KWe solar power pack 21 p0121 A79-17329
- A study for optimum use of metallic plates for thermal storage in solar processes 21 p0122 A79-17331
- Analysis of thermal storage unit for solar energy 21 p0122 A79-17332
- Efficiency of sugar cane and cowpea as solar energy converters 21 p0125 A79-17368
- Direct photoelectrochemical conversion and storage of solar energy 21 p0126 A79-17370
- Saur vidyut kosh - The solar cell --- reversible charging electrolytic batteries 21 p0126 A79-17371
- Harvesting solar energy using biological systems 21 p0126 A79-17372
- Selective coatings for solar energy conversion 21 p0126 A79-17376
- Cost effective optimum design of solar air heaters 21 p0127 A79-17386
- Solar energy use in Denmark /56 deg N/ and higher latitudes in Scandinavia 21 p0128 A79-17393
- Some studies on an experimental solar pond 21 p0131 A79-17416
- A report on the various heat collection and heat storage systems evolved under the solar energy programme at B. I. T. S. 21 p0132 A79-17423
- Liquid solar collector --- low cost assemblage with black water working fluid 21 p0133 A79-17433
- Evacuated solar flat-plate collectors for economic applications 21 p0133 A79-17435
- A Markov model of solar energy systems 21 p0138 A79-17476
- Theoretical basis and design for a residential size solar powered ammonia/water absorption air conditioning system 21 p0139 A79-17479
- A solar heating and cooling system for an industrial plant located in southern Europe 21 p0139 A79-17480
- Solar retrofitting of existing residence with almost zero delta TE system 21 p0139 A79-17485
- Heat transfer analysis of flat plate type domestic solar water heater 21 p0140 A79-17489
- Exploitation of solar energy via modular power plants and multiple utilization of waste heat 21 p0141 A79-17497
- Cycle optimization for a solar turbopack --- turbine water pump utilizing Rankine cycle 21 p0141 A79-17500
- Development of small solar power plants for rural areas in India 21 p0141 A79-17502
- Application of turbopack in solar energy systems 21 p0141 A79-17504
- Power plant systems based on solar energy --- powered by sea water evaporation-produced osmotic pressure head mechanical energy 21 p0142 A79-17508
- A reflector concentrator modified sterling engine unit and an aqua-ammonia absorber gas turbine unit for farm power needs 21 p0142 A79-17509
- 25 kilowatt photovoltaic powered irrigation and grain drying experiment 21 p0143 A79-17519
- Solar irrigation program status 21 p0143 A79-17520
- Use of solar energy for industrial process heat 21 p0143 A79-17524
- The development of a 37 kW solar-powered irrigation system 21 p0144 A79-17525
- Solar Total Energy Control Data Acquisition System 21 p0144 A79-17618
- Master control and data system for the 5MW Solar Thermal Test Facility 21 p0144 A79-17620
- Real time computer control of 5 megawatts of solar thermal energy 21 p0144 A79-17621
- Solar energy --- conversion technologies 21 p0147 A79-17648
- Solar fuels --- photochemical reaction kinetics and energy storage 21 p0149 A79-18009
- Model systems in photoelectrochemical energy conversion 21 p0149 A79-18021
- Structural design of a superheater for a central solar receiver [ASME PAPER 78-WA/PVP-1] 21 p0162 A79-19832
- Parametric analysis of power conversion systems for central receiver solar power generation [ASME PAPER 78-WA/SOL-2] 21 p0162 A79-19835
- Accelerating the commercialization of new technologies --- free market operation of federal alternate energy sources programs [ASME PAPER 78-WA/TS-4] 21 p0164 A79-19849
- Solar-to-thermal energy converter based on coaxial evacuated tubular elements with multilayer and selective coatings 21 p0167 A79-20356
- Thermal calculations for the reactor of a solar-power unit to produce hydrogen by thermolysis of water 21 p0167 A79-20360
- Analysis of the characteristics of silicon photoconverters in the 100-400 K temperature range 21 p0167 A79-20361
- Thermoclines: A solar thermal energy resource for enhanced hydroelectric power production 22 p0237 A79-20730
- Analysis and design of a field of heliostats for a solar power plant 22 p0242 A79-21161
- Experimental investigations of a physical system capable of using solar energy 22 p0247 A79-21667
- Calculation of solar energy incident on non-horizontal surfaces over Turkey 22 p0253 A79-22266
- Solar energy diagrams --- combining position and insolation data 22 p0253 A79-22267
- Solar thermal conversion installations in the medium power range - The Thek project 22 p0254 A79-22269
- Storage efficiency in a solar plant 22 p0254 A79-22270
- A hybrid chemical concept for solar energy storage 22 p0254 A79-22271
- Storage tank efficiency as simulated in a Markovian model of meteorology 22 p0254 A79-22272
- Industrial aspects in solar energy instruction 22 p0254 A79-22274
- Optimizing the conversion mode for solar energy 22 p0258 A79-23125

- Prediction of the behavior of a solar storage system by means of recurrent stochastic models --- of insolation 22 p0258 A79-23295
- Photoelectrolysis of water with semiconductors 22 p0259 A79-23343
- Efficiency of a series of thermoelectric generators in a solar wedge concentrator 22 p0260 A79-23618
- Reversible thermoelectric power conversion of energy fluctuations 22 p0261 A79-23619
- Synthetic chloroplasts --- for photosynthetic solar energy conversion 22 p0262 A79-23721
- Structuring a small national or state solar energy program 22 p0262 A79-23751
- Modeling, simulation, testing, and measurements for solar energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978 22 p0266 A79-24309
- Solar system modeling using a modular approach with generalized programs for working fluid properties 22 p0266 A79-24310
- A liquid solar energy storage tank model. I - Formulation of a mathematical model 22 p0267 A79-24314
- Solar energy for industrial process steam 22 p0267 A79-24315
- Medium-power /100-1000 kWe/ solar power plants using distributed collectors 22 p0269 A79-24622
- Current status and prospects for low-temperature solar energy 22 p0269 A79-24623
- Highly efficient quantum conversion at chlorophyll a-*lecithin* mixed monolayer coated electrodes --- for solar energy conversion 22 p0273 A79-25548
- Space reflector technology and its system implications [AIAA PAPER 79-0545] 22 p0273 A79-25852
- International Solar Energy Conference on the Performance of Solar Heating and Cooling Systems, Duesseldorf, West Germany, April 19, 20, 1978, Proceedings [NATO/CCMS-85] 22 p0275 A79-25926
- What and where - Solar active systems or energy conservation in buildings 22 p0275 A79-25927
- The CCMS solar energy pilot study system performance reporting format 22 p0275 A79-25930
- Passive solar heating system in Turkey 22 p0277 A79-25942
- Photovoltaic power systems for rural areas of developing countries 22 p0278 A79-26131
- Thermal storage and heat transfer in solar energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978 22 p0280 A79-26201
- Earth-conducted heat losses from thermal storage systems 22 p0281 A79-26208
- Solar energy application of natural zeolites --- solid absorber-water vapor working fluid system for sorption-refrigeration cycles 22 p0286 A79-27213
- A proposed thermophotovoltaic solar energy conversion system 22 p0287 A79-27317
- Principles of solar engineering --- Book 22 p0287 A79-27372
- Performance of a 5 MWt solar steam generator 22 p0288 A79-27399
- Optics applied to solar energy IV; Proceedings of the Seminar, San Diego, Calif., August 30, 31, 1978 22 p0293 A79-28140
- Chemical vapor deposited molybdenum films for use in photothermal conversion 22 p0294 A79-28148
- Chemical vapor deposited amorphous silicon for use in photothermal conversion 22 p0294 A79-28149
- Colored stainless steel - A new type of selective absorber --- for solar thermal conversion 22 p0294 A79-28150
- Microstructural characterization of a black chrome solar selective absorber 22 p0294 A79-28151
- New instrumentation for high temperature and hemispherical measurements of selective surfaces --- for solar energy conversion 22 p0294 A79-28152
- Solar thermal electrical power plants for Iran 22 p0295 A79-28352
- A general design method for closed-loop solar energy systems 22 p0295 A79-28359
- Direct solar transmittance for a clear sky --- for insolation of solar conversion systems 22 p0296 A79-28361
- Controlling the radiant flux of a high-temperature solar energy conversion system over two parameters 22 p0296 A79-28669
- Passive solar energy design and materials --- Book 22 p0302 A79-29625
- Space solar power - An energy alternative 22 p0303 A79-29796
- Regulation and control concepts for the possibilities of a utilization of solar energy in the low-temperature range 22 p0305 A79-30345
- A flywheel energy storage and conversion system for solar photovoltaic applications [ASME PAPER 79-SOL-1] 22 p0307 A79-30539
- Design considerations of small solar collector systems using plane heliostats [ASME PAPER 79-SOL-2] 22 p0307 A79-30540
- Review of liquid piston pumps and their operation with solar energy [ASME PAPER 79-SOL-4] 22 p0308 A79-30542
- Photovoltaic concentrator system technology and applications experiments [ASME PAPER 79-SOL-9] 22 p0308 A79-30544
- Field tests of photovoltaic power systems [ASME PAPER 79-SOL-10] 22 p0308 A79-30545
- Solar photovoltaic power for residential use [ASME PAPER 79-SOL-11] 22 p0308 A79-30546
- Photovoltaic electric power generation from a utility perspective [ASME PAPER 79-SOL-16] 22 p0309 A79-30552
- Benefits of solar/fossil hybrid gas turbine systems [ASME PAPER 79-GT-38] 22 p0309 A79-30554
- Thermodynamics of the conversion of diluted radiation --- solar energy application 22 p0310 A79-30910
- Production of mechanical energy by thermodynamic conversion of solar energy 22 p0310 A79-30999
- Thermal energy storage 22 p0310 A79-31000
- Direct conversion of solar energy into laser radiation 22 p0311 A79-31086
- Biological conversion of solar energy 22 p0312 A79-31146
- Renewable alternatives; Proceedings of the Fourth Annual Conference, University of Western Ontario, London, Canada, August 20-24, 1978. Volumes 1 & 2 22 p0316 A79-31401
- The role of applied meteorology in the Canadian energy programme 22 p0317 A79-31414
- Solar power plants --- thermoelectric conversion in Canada 22 p0318 A79-31416
- Sensible heat storage for solar energy applications 22 p0322 A79-31449
- Photovoltaics and solar thermal conversion to electricity - Status and prospects 22 p0326 A79-31924
- Solar energy in developing countries: An overview and buyers' guide for solar scientists and engineers --- Book 22 p0327 A79-32139
- Solar energy - Four sites demonstrate potential 22 p0328 A79-32194

Solar tracking control system Sun Chaser  
[NASA-TM-78199] 21 p0172 N79-10514

Solar heating and cooling system design and development  
[NASA-CR-150803] 21 p0172 N79-10516

Rankine cycle machines for solar cooling  
[NASA-TM-78196] 21 p0173 N79-10524

Solar photolysis of water  
[NASA-CASE-WPO-14126-1] 21 p0182 N79-11470

Biomimetic approach to solar energy conversion: Artificial photosynthesis  
[CONP-780222-5] 21 p0186 N79-11506

Specific heat variations in oil energy storage media and their economic implications  
[SAND-78-8672] 21 p0189 N79-11537

Silicon Schottky photovoltaic diodes for solar energy conversion  
[PB-283998/3] 21 p0198 N79-12572

Biological solar energy conversion approaches to overcome yield stability and product limitations  
[PB-284823/2] 21 p0199 N79-12577

SIMS prototype system 4 - performance test report  
[NASA-CR-150820] 21 p0205 N79-13499

Solar heating and cooling. Research and development: Project summaries  
[DOE/CS-0010] 21 p0208 N79-13519

Component-based simulator for solar systems  
[LA-UR-78-1494] 21 p0208 N79-13521

Application of solar technology to today's energy needs, volume 2 --- systems analysis and analytical methods  
[OTA-E-77-VOL-2] 21 p0218 N79-14530

Analytical methods 21 p0218 N79-14531

Calculation of backup requirements 21 p0218 N79-14533

Results of systems analysis --- effectiveness of integrated solar energy systems 21 p0218 N79-14534

A detailed analysis of the impact of onsite equipment on utility costs --- marginal costs of providing backup power for solar energy systems 21 p0218 N79-14535

Preliminary economic analysis of Solar Irrigation Systems (SIS) for selected locations  
[SAND-77-1403] 21 p0220 N79-14566

OAST Space Theme Workshop. Volume 2: Theme summary. 1: Space power (no. 7). A. Theme statement. B. 26 April 1976 presentation. C. Summary. D. Initiative action  
[NASA-TM-80002] 21 p0225 N79-15114

Solar heating and hot water system installed at Listerhill, Alabama  
[NASA-CR-150870] 21 p0229 N79-15406

Preliminary design package for prototype solar heating and cooling systems  
[NASA-CR-150853] 21 p0229 N79-15409

Benefits of solar/fossil hybrid gas turbine systems  
[NASA-TM-79083] 21 p0229 N79-15410

Biological solar energy conversion: Approaches to overcome yield, stability and product limitations  
[PB-286487/4] 21 p0230 N79-15422

Satellite Power System (SPS) program summary  
[DOE/ER-0022] 22 p0337 N79-16893

Certification report for the CALMAC solar powered pump  
[NASA-CR-150872] 22 p0341 N79-17331

Photovoltaic tests and applications project  
[NASA-TM-79018] 22 p0342 N79-17336

Development, testing, and certification of Calmac Hfg. Corp. solar collector and solar operated pump  
[NASA-TM-78218] 22 p0342 N79-17338

Silicon Schottky photovoltaic diodes for solar energy conversion  
[PB-287417/0] 22 p0343 N79-17349

Thermal energy transformer  
[NASA-CASE-WPO-14058-1] 22 p0348 N79-18443

Solar water heating  
[BHPT-PE-T-77-42] 22 p0349 N79-18457

Austrian 10kWE solar power plant. A project of the Federal Ministry for Science and Research  
22 p0349 N79-18460

Large area silicon sheet by EFG  
[NASA-CR-158379] 22 p0359 N79-20483

The parabolic concentrating collector: A tutorial  
[NASA-CR-158246] 22 p0359 N79-20491

Laser power conversion system analysis, volume 1  
[NASA-CR-159523-VOL-1] 22 p0366 N79-21334

Laser power conversion system analysis, volume 2  
[NASA-CR-159523-VOL-2] 22 p0366 N79-21335

**SOLAR FLUX**  
A numerical solar radiation model based on standard meteorological observations --- for energy system application 21 p0041 A79-11871

**SOLAR FLUX DENSITY**  
Dependence of solar radiation availability on atmospheric turbidity 21 p0119 A79-17308

Determining the terrestrial, incident solar flux on an arbitrarily oriented surface using available solar/weather data 21 p0119 A79-17310

Solar radiation studies for utilization of flat-plate collectors in an equatorial region 21 p0119 A79-17311

Total solar radiation in Mexico using sunshine hours and meteorological data 21 p0150 A79-18026

Composite heliostats of large solar plants 21 p0166 A79-20350

Isotropic distribution approximation in solar energy estimations --- diffuse insolation on tilted surface 22 p0262 A79-23753

**SOLAR FURNACES**  
Solar furnace type high power density thermoelectric generator 21 p0027 A79-10229

Study of the dynamics of the materials melting process for a solar furnace 21 p0167 A79-20359

Flux-redistribution in the focal region of a planar Fresnel ring mirror --- solar furnace design 22 p0263 A79-23764

Analysis of a Cassegrain solar furnace 22 p0293 A79-28147

**SOLAR GENERATORS**  
Preliminary design of the solar total energy-large scale experiment at Shenandoah, Georgia 21 p0019 A79-10159

Conceptual design of the Fort Hood Solar Total Energy-Large Scale Experiment 21 p0019 A79-10160

JPL - Small Power Systems Applications Project --- for solar thermal power plant development and commercialization 21 p0019 A79-10161

Performance and economic risk evaluation of dispersed solar thermal power systems by Monte Carlo simulation 21 p0020 A79-10163

The application of solar thermoelectric generators in near-sun missions 21 p0023 A79-10187

A free-piston Stirling engine for small solar power plants 21 p0024 A79-10205

Economic methodology for solar power-generating systems 21 p0030 A79-10251

Solar thermal electric power systems - Manufacturing cost estimation and systems optimization 21 p0046 A79-12273

Solar electric power supplies - Design and layout 21 p0057 A79-13639

Solar power plants in the U.S.A. 21 p0057 A79-13640

Development of solar thermal power plants 21 p0057 A79-13641

Small solar power plant with a Freon turbine 21 p0057 A79-13642

Solar thermal power stations 21 p0057 A79-13644

Solar One - A 10-megawatt solar thermal central receiver pilot plant project  
[AIAA PAPER 78-1750] 21 p0060 A79-13853

Dynamic computer simulation of the DOE 10 MW solar thermal pilot plant  
[AIAA PAPER 78-1752] 21 p0060 A79-13854

Alternative central receiver solar power plant using salt as a heat transfer and storage medium  
[AIAA PAPER 78-1753] 21 p0060 A79-13855

- Solar thermal power systems point-focusing distributed receiver /PPDR/ technology - A project description [AIAA PAPER 78-1771] 21 p0062 A79-13869
- Preliminary design of solar total energy - Large scale experiment at Shenandoah, Georgia [AIAA PAPER 78-1776] 21 p0062 A79-13873
- Flexible roll-out solar generators - Energy sources for future high-power space missions [DGLR PAPER 78-165] 21 p0063 A79-14056
- Solar energy installations for pumping irrigation water 21 p0066 A79-14260
- Exploring future energy options - An economic analysis 21 p0068 A79-14324
- MHD conversion of solar energy --- space electric power system 21 p0109 A79-16614
- A comparison between sun and wind as energy sources in irrigation plants 21 p0118 A79-17295
- Simulation and cost of photovoltaic generators 21 p0122 A79-17334
- Design of solar energy concentrators for power generation in residential and nonresidential areas 21 p0136 A79-17460
- The attainable efficiency of the solar thermoelectric generators 21 p0140 A79-17496
- The French CNRS 1 MW solar power plant 21 p0141 A79-17498
- Cycle optimization for a solar turbopack --- turbine water pump utilizing Rankine cycle 21 p0141 A79-17500
- A small solar power plant with a freon turbine 21 p0141 A79-17501
- Development of small solar power plants for rural areas in India 21 p0141 A79-17502
- Design and performance of 1/4 H.P. solar power unit 21 p0141 A79-17503
- 1MW calorimetric receiver for Solar Thermal Test Facility. [ASME PAPER 78-WA/SOL-7] 21 p0163 A79-19839
- Optimization and design of radiative heat-discharge system for energy unit with Stirling engine --- operating in planetary environment 21 p0166 A79-20348
- Determination of thermal contact resistances --- for solar thermoelectric generators 21 p0166 A79-20351
- Using H2O4 in a solar gas-turbine plant 21 p0167 A79-20357
- Experimental investigation of the joint operation of wind and solar plants 21 p0167 A79-20358
- Universal generator storer curves --- Economic and relative size optimization of solar photovoltaic energy 22 p0238 A79-20799
- A ceramic heat exchanger for a Brayton cycle solar electric power plant 22 p0239 A79-20822
- Solar thermal conversion installations in the medium power range - The Thek project 22 p0254 A79-22269
- Design concepts of solar thermoelectric generators in space applications 22 p0260 A79-23612
- Reversible thermoelectric power conversion of energy fluctuations 22 p0261 A79-23619
- Solar thermal electric power systems - Comparison of line-focus collectors 22 p0263 A79-23758
- Use of organic fluids in solar turbines 22 p0269 A79-24621
- Power from space by laser 22 p0284 A79-26596
- Solar power satellites - The laser option 22 p0284 A79-26599
- Conceptual design of a solar powered closed-cycle gas turbine electric power generation system [ASME PAPER 79-GT-43] 22 p0306 A79-30522
- Investigation of the heat transfer in cylindrical receiver configurations with inner tubes [ASME PAPER 79-GT-64] 22 p0306 A79-30532
- Field tests of photovoltaic power systems [ASME PAPER 79-SOL-10] 22 p0308 A79-30545
- Achievable flatness in a large microwave power antenna study [NASA-CR-151831] 21 p0171 A79-10272
- Solar irrigation program plan: Second revision [SAND-78-0308-BEV] 21 p0187 A79-11525
- Solar thermal power systems program: Program summary [DOE/ET-0018/1] 21 p0207 A79-13518
- Solar electric power generation, volume 2. Citations from the NTIS data base [NTIS/PS-78/1108/6] 21 p0212 A79-13557
- Solar electric power generation, volume 2. Citations from the Engineering Index data base [NTIS/PS-78/1109/4] 21 p0212 A79-13558
- Accuracy analysis of pointing control system of solar power station [NASA-CR-150880] 21 p0215 A79-14143
- Solar power satellite rectenna design study: Directional receiving elements and parallel-series combining analysis [NASA-CR-151866] 22 p0330 A79-16039
- Assessment of the potential of solar thermal small power systems in small utilities [NASA-CR-158093] 22 p0335 A79-16377
- Solar water pumps. Citations from the Engineering Index data base [NTIS/PS-78/1288/6] 22 p0343 A79-17348
- Development of a phase-change thermal storage system using modified anhydrous sodium hydroxide for solar electric power generation [NASA-CR-159465] 22 p0354 A79-19454
- Thermal storage technologies for solar industrial process heat applications [NASA-TN-79130] 22 p0360 A79-20498
- SOLAR HEATING**
- Can solar energy contribute significantly to the solution of the world's energy famine 21 p0019 A79-10155
- Analysis and design of an 18-ton solar-powered heating and cooling system 21 p0019 A79-10156
- Conceptual design of the Fort Hood Solar Total Energy-Large Scale Experiment 21 p0019 A79-10160
- Central solar heat stations and the Studsvik Demonstration Plant 21 p0021 A79-10175
- Thermosyphon solar water heating system under Brazilian conditions 21 p0021 A79-10177
- Heat pipe central solar receiver gas turbine plant 21 p0022 A79-10178
- The fossil fuel cost of solar heating 21 p0022 A79-10180
- Nitinol heat engines for economical conversion of low grade thermal density 21 p0027 A79-10230
- Application of composite materials in the solar energy domain 21 p0034 A79-11195
- Asymptotic behaviour as a guide to the long term performance of solar water heating systems 21 p0041 A79-11872
- Optics applied to solar energy conversion; Proceedings of the Seminar, San Diego, Calif., August 23, 24, 1977 21 p0042 A79-11965
- Return flow solar air-heater 21 p0055 A79-13609
- Control of solar energy systems, heat storage, and heat utilization 21 p0056 A79-13630
- Simple high-accuracy diode temperature-difference control circuit 21 p0056 A79-13631
- The Arbonia control concept - Does flow regulation in the solar system cycle make sense --- working fluid regulation in solar heating facility 21 p0056 A79-13632
- Solar heating and safety techniques 21 p0056 A79-13633
- Safety requirements for solar heating systems - Practical considerations 21 p0056 A79-13634
- Sea water desalination by means of solar energy 21 p0057 A79-13645

- Design of a low-energy house in Denmark heated by a combination of solar and wind energy 21 p0058 A79-13652
- Vacation homes near the sea with solar and wind energy utilization - Research done at the Technical University of Hannover: Architectural considerations 21 p0058 A79-13653
- On the thermal and thermo-electrolytical generation of hydrogen by solar energy 21 p0059 A79-13660
- Passive solar heating and cooling [AIAA PAPER 78-1756] 21 p0060 A79-13857
- Evaluation of control options for solar climate control systems [AIAA PAPER 78-1758] 21 p0060 A79-13859
- The ClearView Solar Collector system and associated one and two stage evaporative cooling - Interim results [AIAA PAPER 78-1759] 21 p0061 A79-13860
- Jet impingement solar air heater [AIAA PAPER 78-1760] 21 p0061 A79-13861
- The economic performance of passive solar heating - A preliminary analysis --- thermal storage wall for family home design [AIAA PAPER 78-1761] 21 p0061 A79-13862
- Metal hydride solar heat pump and power system /HYCSOS/ [AIAA PAPER 78-1762] 21 p0061 A79-13863
- Preliminary design of solar total energy - Large scale experiment at Shenandoah, Georgia [AIAA PAPER 78-1776] 21 p0062 A79-13873
- A hybrid thermochemical hydrogen production cycle using solar energy process heat [AIAA PAPER 78-1779] 21 p0062 A79-13874
- Optimal sizing of solar collectors by the method of relative areas 21 p0066 A79-14263
- Solar and wind energy applications in Hawaii 21 p0066 A79-14265
- Alternative energy for domestic hot water - Wind or solar 21 p0067 A79-14292
- Barriers and incentives to the commercialization of solar heating and cooling of buildings 21 p0072 A79-14687
- The National Program for Solar Energy 21 p0072 A79-14688
- Economic optimization of heatpump assisted solar heating in Illinois 21 p0072 A79-14691
- Passive solar design --- for domestic heating and cooling systems 21 p0074 A79-14720
- A microprocessor based solar controller 21 p0082 A79-14979
- Conference on Performance Monitoring Techniques for Evaluation of Solar Heating and Cooling Systems, Washington, D.C., April 3, 4, 1978, Proceedings 21 p0087 A79-15826
- Analysis of data user's needs for performance evaluation of solar heating and cooling systems 21 p0087 A79-15827
- Collection of data for estimating the probable life cycle costs of solar energy systems 21 p0087 A79-15828
- Acceleration of solar heating application via improved data evaluation 21 p0087 A79-15829
- Technique and instrumentation for measuring the performance of integrated solar heating/cooling systems 21 p0087 A79-15830
- Data acquisition using a modular data logger --- for solar heated building monitoring 21 p0088 A79-15832
- The use of computer-controlled data acquisition systems in determining solar heating and cooling system performance 21 p0088 A79-15834
- System performance measurements for a packaged solar space heating system equipped with air-heating collectors 21 p0088 A79-15835
- Instrumentation, data acquisition and monitoring system for an air heating solar system 21 p0088 A79-15836
- Flow rate calibration for solar heating and cooling system evaluation 21 p0089 A79-15845
- Temperature calibration for solar heating and cooling system evaluation 21 p0089 A79-15846
- Boosting the performance of solar HVAC systems by improving component interactions --- Heating, Ventilating and Air Conditioning 21 p0089 A79-15851
- Tracking high temperature collectors 21 p0090 A79-15856
- Solar energy for residential housing 21 p0090 A79-15857
- Passive solar heating of buildings [LA-OR-77-1162] 21 p0090 A79-15859
- Design of active solar heating systems 21 p0090 A79-15860
- Solar total energy systems 21 p0090 A79-15863
- Theory of solar assisted heat pumps 21 p0090 A79-15864
- Residential and commercial thermal storage --- for solar heating and cooling systems 21 p0090 A79-15865
- An overview of solar markets 21 p0092 A79-15884
- Solar heating and cooling - An electric utility perspective 21 p0093 A79-15890
- Solar-earth homes and cities --- in-ground solar heated dwellings 21 p0098 A79-16105
- The Solar Heating and Cooling Commercial Demonstration Program at Marshall Space Flight Center - Some problems and conclusions 21 p0099 A79-16135
- Controls for residential solar heating 21 p0101 A79-16418
- Solar controls and control modifications - New century town solar homes, Vernon Hills, IL 21 p0102 A79-16419
- Controls for heat reclaim with thermal storage coupled with solar heating 21 p0102 A79-16420
- Using controls to reduce component size, and energy needs for solar HVAC --- Heating Ventilation, Air Conditioning 21 p0102 A79-16421
- Principles of solar cooling and heating 21 p0103 A79-16457
- A microprocessor-based control system for solar heating and cooling 21 p0107 A79-16565
- Economic evaluation and optimization of solar heating systems 21 p0118 A79-17293
- The economics of solar heating and cooling - A cautious view 21 p0119 A79-17297
- A solar energy system with a dual-source heat pump and long-term storage 21 p0119 A79-17312
- Long-term storage of solar energy in native rock 21 p0120 A79-17314
- Performance studies of a finned heat pipe latent thermal energy storage system 21 p0121 A79-17325
- Stratification effects in the short and long term storage of solar heat 21 p0121 A79-17326
- Investigation on the feasibility of using a two-phase thermosyphon for solar storage, space heating and cooking 21 p0121 A79-17330
- A study for optimum use of metallic plates for thermal storage in solar processes 21 p0122 A79-17331
- Concentrator photovoltaic systems for economical electricity and heat 21 p0124 A79-17354
- Cost effective optimum design of solar air heaters 21 p0127 A79-17386
- Cheap packed bed absorbers for solar air heaters 21 p0128 A79-17388
- An analytical and experimental study of pumped solar water heaters 21 p0128 A79-17389

# SUBJECT INDEX

# SOLAR HEATING CONTD

- Economic use of materials in the design of solar water-heating collector plates of the pipe and fin type 21 p0129 A79-17396
- Thermal performance of solar collectors used in the national solar heating and cooling demonstration program 21 p0130 A79-17403
- Proposal for efficient appreciation of solar thermal absorptive materials by high irradiance solar simulator 21 p0130 A79-17406
- Testing of water-heating collectors according to ASHRAE Standard 93-77 21 p0130 A79-17410
- Double-exposure collector system for solar heating applications 21 p0131 A79-17411
- Annual collection and storage of solar energy for the heating of buildings 21 p0131 A79-17415
- A report on the various heat collection and heat storage systems evolved under the solar energy programme at B. I. T. S. 21 p0132 A79-17423
- Availability of solar energy at Baghdad, Iraq - Performance and design data for flat plate collectors 21 p0133 A79-17428
- Theoretical and experimental yields of a solar heater with flat plate collectors 21 p0134 A79-17437
- Compound parabolic concentrators with non-evacuated receivers - Prototype performance and a larger scale demonstration in a school heating system 21 p0134 A79-17440
- Receiver designs for tower-top solar collector 21 p0135 A79-17450
- Comparison between simulation and experiment of solar heating 21 p0137 A79-17461
- Design, operation and performance of the BBC Solar House 21 p0137 A79-17462
- Analysis and design of solar buildings using the Cal-ERDA computer programs 21 p0137 A79-17463
- Experiments in solar space heating and cooling for moderately insulated regions 21 p0137 A79-17464
- Solar heating performance of the Toshiba Solar House No. 1 21 p0137 A79-17465
- The analysis by stochastic modelling of solar systems for space and water heating 21 p0137 A79-17466
- Space heating with solar all-air systems - CSU Solar House II 21 p0137 A79-17467
- The interface with solar - Alternative auxiliary supply systems --- for solar space heating 21 p0137 A79-17468
- Some experimental investigations on solar space heating in Korea 21 p0138 A79-17470
- Design problems of air source solar boosted heat pumps 21 p0138 A79-17472
- Heat tube, a universal electrical solar heat equipment for building, community and agricultural purposes 21 p0138 A79-17473
- Optimizing solar energy systems using continuous flow control 21 p0138 A79-17477
- Performance of solar heating and cooling systems used in the national solar heating and cooling demonstration program 21 p0139 A79-17478
- A solar heating and cooling system for an industrial plant located in southern Europe 21 p0139 A79-17480
- Design of solar heating system for winter heating of buildings /A case study/ 21 p0139 A79-17486
- A heat operated mechanical device to control the temperature and flow of water entering a hot water storage tank in a solar water heating system 21 p0140 A79-17487
- Dynamic response of a novel solar water heater --- collector using low-boiling liquid between flat plates 21 p0140 A79-17488
- Heat transfer analysis of flat plate type domestic solar water heater 21 p0140 A79-17489
- Optimum insulation with internal and solar heat gains 21 p0140 A79-17490
- Periodic heating/cooling by solar radiation --- through concrete slab buildings 21 p0140 A79-17491
- Solar heating for a novel dwelling independent of servicing networks 21 p0140 A79-17492
- Enhancement of intrinsic solar heating --- thermal performance of house design option 21 p0140 A79-17494
- Experimental investigation on solar house heating in northern India 21 p0140 A79-17495
- Medium capacity heliothermal power stations 21 p0142 A79-17507
- Solar energy --- conversion technologies 21 p0147 A79-17648
- Properties optimization for phase-change energy storage in air-based solar heating systems 21 p0149 A79-18018
- A cavity receiver design for solar heated gas turbine generating systems [ONERA, TP NO. 1978-137] 21 p0155 A79-18560
- An optimal standard for solar heating systems [ASME PAPER 78-WA/DSC-19] 21 p0159 A79-19765
- Structural design of a superheater for a central solar receiver [ASME PAPER 78-WA/PVP-1] 21 p0162 A79-19832
- Limitations of solar assisted heat pump systems [ASME PAPER 78-WA/SOL-1] 21 p0162 A79-19834
- Solar collector storage panel [ASME PAPER 78-WA/SOL-12] 21 p0163 A79-19844
- Investigations of solar heat production for household heating in Turkey 22 p0253 A79-22265
- Solar heating using a heat pump and cold collectors 22 p0254 A79-22268
- Solar water heaters for a cold climate 22 p0254 A79-22325
- Experiments with a flat plate solar water heating system in thermosiphonic flow 22 p0262 A79-23755
- Prediction of the performance of solar heating systems utilizing annual storage 22 p0263 A79-23760
- Optimum collector slope for residential heating in adverse climates 22 p0263 A79-23761
- Effects of low solar input and amount of storage on thermosyphon hot water system performance 22 p0267 A79-24312
- A computer simulation model for determining preferred solar heating and cooling systems 22 p0267 A79-24313
- Solar storage unit with built-in oil-gas boiler 22 p0268 A79-24322
- A test bed for thermosyphon solar air collectors [AIAA PAPER 79-0541] 22 p0274 A79-25860
- International Solar Energy Conference on the Performance of Solar Heating and Cooling Systems, Dusseldorf, West Germany, April 19, 20, 1978, Proceedings [BATO/CCMS-85] 22 p0275 A79-25926
- Passive solar heating of buildings 22 p0275 A79-25928
- Prospects for solar heating and cooling in the United States 22 p0275 A79-25929
- Solar heating, cooling and hot water production - A critical look at CCMS installations 22 p0275 A79-25931
- Solar air heating and nocturnal cooling system /CSU Solar House II/ 22 p0275 A79-25932
- Dornier/BWE solar house in Essen, FRG 22 p0276 A79-25933

Experience with the MBB-solar testing house at Otterfing and relevant consequences on the commercial product 22 p0276 A79-25934

Mississauga solar house /Mississauga, Ontario, Canada/ 22 p0276 A79-25935

Solar houses in Blagnac /Blagnac, Haute-Garonne, France/ 22 p0276 A79-25937

The performance of the heating system in the solar house of the Eindhoven University of Technology 22 p0276 A79-25938

Performance of residential solar heating and cooling system with flat-plate and evacuated tubular collectors - CSU Solar House I 22 p0276 A79-25939

Passive solar heating system in Turkey 22 p0277 A79-25942

Passive solar house in Vetlanda - Interim report 22 p0277 A79-25943

Solar heating and cooling performance of the Los Alamos National Security and Resources Study Center 22 p0277 A79-25944

Design considerations for residential solar heating and cooling systems utilizing evacuated tube solar collectors 22 p0285 A79-26815

Performance of combined solar-heat pump systems 22 p0285 A79-26817

Heat loss characteristics of an evacuated plate-in-tube collector 22 p0285 A79-26818

Solar energy application of natural zeolites --- solid absorber-water vapor working fluid system for sorption-refrigeration cycles 22 p0286 A79-27213

Economic feasibility of solar water and space heating 22 p0292 A79-27899

A Markov model of solar energy space and hot water heating systems 22 p0295 A79-28353

Study of the temperature distribution across the width of the screen of low-temperature water heaters with tubular heat receivers 22 p0297 A79-28671

Passive solar energy design and materials --- Book 22 p0302 A79-29625

Regulation and control concepts for the possibilities of a utilization of solar energy in the low-temperature range 22 p0305 A79-30345

Case history - Hybrid passive/active solar system: Performance and cost 22 p0313 A79-31315

Heat pump design - Cost effectiveness in the collection, storage and distribution of solar energy 22 p0313 A79-31316

Studies on the effect of bed aspect ratios and pressure drop on flow distribution in rock bed storage systems for solar energy applications 22 p0317 A79-31409

Distributed energy storage for solar applications 22 p0317 A79-31410

Report on a survey of operational solar systems 22 p0318 A79-31418

NRC solar monitoring program 22 p0318 A79-31419

Measured and predicted performance of solar domestic water heaters 22 p0319 A79-31422

New approaches for the appropriate use of solar energy in northern climates 22 p0319 A79-31424

Component cost of solar energy systems 22 p0319 A79-31429

A cost effective vertical air/water solar heating collector 22 p0320 A79-31430

Collector and storage efficiencies in solar heating systems 22 p0320 A79-31432

Design study on solar energy systems for commercial buildings 22 p0320 A79-31433

Solar energy retrofit system for an older-type building - The Williamstown Museum project 22 p0320 A79-31434

Solar heating and ventilation using the modified Trombe wall system 22 p0320 A79-31435

Domestic water preheating using solar energy 22 p0321 A79-31437

Economic design of a solar domestic water heating system 22 p0321 A79-31438

WATSUN - A simulation program for solar-assisted heating systems 22 p0321 A79-31439

Validation of an electric circuit model of a solar house 22 p0321 A79-31440

Mathematical modelling of passive solar systems 22 p0321 A79-31441

Control system for solar hot water system 22 p0321 A79-31442

Solutions to energy conservation in northern climates 22 p0321 A79-31443

Passive solar heating - Results from two Saskatchewan residences 22 p0322 A79-31444

Measured and modeled passive performance in Montana --- for solar heating and thermal storage 22 p0322 A79-31445

Integration of a passive and active solar heated, low density, multiple dwelling with atrium 22 p0322 A79-31446

Studies on solar collector performance at NRC 22 p0322 A79-31451

First year performance data and lessons learned in the NRC 14 house solar demonstration program 22 p0323 A79-31453

Alternate energy installations on the Jordan College Campus 22 p0323 A79-31454

Solar heating of domestic hot water at the Confederation Heights Cafeteria 22 p0323 A79-31457

P.E.I. solar assisted domestic water heat project 22 p0323 A79-31458

Solar energy - Four sites demonstrate potential 22 p0328 A79-32194

Solar heating and cooling system design and development [NASA-CR-150803] 21 p0172 A79-10516

Solar system installation at Louisville, Kentucky [NASA-CR-150814] 21 p0172 A79-10518

Cost analysis of new and retrofit hot-air type solar assisted heating systems [NASA-TN-78186] 21 p0173 A79-10519

Preliminary design package for solar heating and hot water system [NASA-CR-150619] 21 p0173 A79-10520

Solar heating and cooling demonstration project summaries [DOE/CS-0009] 21 p0186 A79-11503

Prototype solar heating and cooling systems [NASA-CR-150828] 21 p0196 A79-12552

MSPC hot air collectors [NASA-TN-78206] 21 p0196 A79-12556

Instrumentation at the Decade 80 solar house in Tucson, Arizona [NASA-CR-150851] 21 p0204 A79-13491

Large hot water system long range thermal performance test report, addendum [NASA-CR-150842] 21 p0204 A79-13492

Prototype solar-heated hot water systems and double-valled heat exchangers [NASA-CR-150854] 21 p0205 A79-13495

SIMS prototype system 4 - performance test report [NASA-CR-150820] 21 p0205 A79-13499

Solar assisted heat pump study for heating of military facilities [AD-A058626] 21 p0206 A79-13506

Evaluation of high performance evacuated tubular collectors in a residential heating and cooling system: Colorado State University Solar House 1 [COO-2577-14] 21 p0206 A79-13507

Solar Heating And Cooling Of Buildings (SHACOB) commercialization report. Part A: Options and strategies. Volume 1: Executive summary [HCP/870065-01/1] 21 p0207 A79-13512



## SUBJECT INDEX

## SOLAR HOUSES

- Solar Heating And Cooling Of Buildings (SHACOB) commercialization report. Part B: Analysis of market development, volume 2  
[HCP/M70066-01/2] 21 p0207 879-13513
- Solar heating and cooling. Research and development: Project summaries  
[DOE/CS-0010] 21 p0208 879-13519
- Legal barriers to solar heating and cooling of buildings  
[HCP/M2528-1] 21 p0209 879-13534
- Solar space heating and air conditioning, volume 2. Citations from the NTIS data base  
[NTIS/PS-78/1014/6] 21 p0211 879-13545
- Solar space heating and air conditioning volume 3. Citations from the NTIS data base  
[NTIS/PS-78/1015/3] 21 p0211 879-13546
- Solar space heating and air conditioning, volume 3. Citations from the engineering index data base  
[NTIS/PS-78/1017/9] 21 p0211 879-13547
- Solar space heating and air conditioning, volume 2. Citations from the engineering index data base  
[NTIS/PS-78/1016/1] 21 p0212 879-13550
- Design and installation package for solar hot water system  
[NASA-CR-150859] 21 p0220 879-14556
- Preliminary design package for prototype solar heating system  
[NASA-CR-150858] 21 p0220 879-14557
- Passive thermosyphon solar heating and cooling module with supplementary heating  
[NASA-CR-150849] 21 p0229 879-15402
- Use of solar energy to heat anaerobic digesters. Part 1: Technical and economic feasibility study. Part 2: Economic feasibility throughout the United States  
[PB-286940/2] 21 p0231 879-15440
- System design package for SIMS prototype system 3, solar heating and domestic hot water  
[NASA-CR-150840] 22 p0333 879-16359
- System design package for SIMS prototype system 4, solar heating and domestic hot water  
[NASA-CR-150839] 22 p0333 879-16361
- Prototype solar heating and cooling systems including potable hot water  
[NASA-CR-150861] 22 p0334 879-16372
- Installation package for Hyde Memorial Observatory, Lincoln, Nebraska  
[NASA-CR-150867] 22 p0334 879-16373
- State-of-the-art study of heat exchangers used with solar assisted domestic hot water systems (potential contamination of potable water supply)  
[PB-287410/5] 22 p0343 879-17351
- System integration of marketable subsystems --- for residential solar heating and cooling  
[NASA-CR-161104] 22 p0348 879-18448
- Installation package for a solar heating system  
[NASA-CR-150876] 22 p0349 879-18454
- Solar water heating  
[BHPT-PB-T-77-42] 22 p0349 879-18457
- Solar heating of buildings: Design optimization and economic analysis  
22 p0353 879-19439
- Solar building regulatory study, volume 2  
[PB-289824/5] 22 p0357 879-20291
- Cost analysis and optimization study for solar heating and cooling systems, Stillwater, Minnesota and Newcastle, Pennsylvania  
[NASA-CR-161201] 22 p0358 879-20478
- A fixed tilt solar collector employing reversible vee-through reflectors and evaluated tube receivers for solar heating and cooling systems  
[NASA-CR-158420] 22 p0359 879-20490
- Verification test report on a solar heating and hot water system  
[NASA-CR-161165] 22 p0360 879-20493
- Cost analysis and optimization study for solar heating and cooling systems  
[NASA-CR-161200] 22 p0360 879-20499
- Design of solar heating and cooling systems  
[AD-A062719] 22 p0363 879-20522
- Solar energy pilot study  
[PB-289380/8] 22 p0363 879-20525
- Solar space heaters for low-income families  
[PB-289244/6] 22 p0363 879-20526
- Solar building regulatory study, volume 1  
[PB-289823/7] 22 p0365 879-21235
- Design package for programmable controller and hydronic subsystem  
[NASA-CR-161151] 22 p0371 879-21619
- Interim performance criteria for solar heating and cooling systems in residential buildings, second edition  
[PB-289967/2] 22 p0372 879-21630
- Report of the 4th CCMS (Committee on the Challenges of Modern Society) Solar Energy Pilot Study Meeting  
[PB-289492/1] 22 p0372 879-21631
- SOLAR HOUSES**
- Design of a low-energy house in Denmark heated by a combination of solar and wind energy  
21 p0058 879-13652
- Vacation homes near the sea with solar and wind energy utilization - Research done at the Technical University of Hannover: Architectural considerations  
21 p0058 879-13653
- Total energy systems --- domestic solar and windpowered facilities  
21 p0058 879-13654
- The economic performance of passive solar heating - A preliminary analysis --- thermal storage wall for family home design  
[AIAA PAPER 78-1761] 21 p0061 879-13862
- Predicting the performance of passive solar-heated buildings  
21 p0063 879-13899
- A solar energy system for space heating and space cooling --- retrofitting aged buildings  
21 p0072 879-14686
- Passive solar design --- for domestic heating and cooling systems  
21 p0074 879-14720
- Data acquisition using a modular data logger --- for solar heated building monitoring  
21 p0088 879-15832
- Experience gained and lessons learned from monitoring the solar building, Albuquerque  
21 p0088 879-15833
- Instrumentation, data acquisition and monitoring system for an air heating solar system  
21 p0088 879-15836
- Moderate cost, calculator-based data acquisition for solar HVAC systems  
21 p0088 879-15837
- A microprocessor based solar monitoring system  
21 p0088 879-15838
- A microprocessor compatible temperature measuring system --- for solar house energy monitoring  
21 p0088 879-15839
- A microprocessor monitoring system for a solar energy installation  
21 p0088 879-15840
- Design of the data acquisition system at Solar One --- home energy monitoring via minicomputers  
21 p0088 879-15841
- A low cost approach to performance monitoring for the evaluation of a solar domestic hot water system  
21 p0088 879-15842
- Low-cost monitoring of solar system performance  
21 p0088 879-15843
- Solar energy for residential housing  
21 p0090 879-15857
- Design of active solar heating systems  
21 p0090 879-15860
- Solar heating and cooling - An electric utility perspective  
21 p0093 879-15890
- Solar-earth homes and cities --- in-ground solar heated dwellings  
21 p0098 879-16105
- Solar controls and control modifications - New century town solar homes, Vernon Hills, IL.  
21 p0102 879-16419
- Solar heating and ventilating by natural means  
21 p0103 879-16458
- Inexpensive solar energy utilization in human settlements  
21 p0104 879-16470
- Impacts of the National Energy Plan on solar economics  
[CONF-771203-6] 21 p0118 879-17294
- Long-term thermal storage in solar architecture in northern latitudes, with reference to typical single family dwellings  
21 p0119 879-17313

## SOLAR HOUSES CONTD

## SUBJECT INDEX

- Investigation of physical and chemical properties of phase change materials for space heating/cooling applications 21 p0120 A79-17319
- A passive integrated unit for the collection, thermal storage in fusion materials and distribution of solar energy for home heating and other applications 21 p0121 A79-17322
- A thermal storage analysis on packed bed of alumina spheres --- in solar houses 21 p0121 A79-17324
- Use of monolithic structures for the short term storage of solar energy 21 p0121 A79-17327
- A passive rock bed - Design, construction, and performance 21 p0121 A79-17328
- Investigation on the feasibility of using a two-phase thermosiphon for solar storage, space heating and cooking 21 p0121 A79-17330
- Tilt, orientation and overshadowing of solar collectors in the Netherlands 21 p0131 A79-17414
- Comparison between simulation and experiment of solar heating 21 p0137 A79-17461
- Design, operation and performance of the BBC Solar House 21 p0137 A79-17462
- Analysis and design of solar buildings using the Cal-ERDA computer programs 21 p0137 A79-17463
- Solar heating performance of the Toshiba Solar House No. 1 21 p0137 A79-17465
- The analysis by stochastic modelling of solar systems for space and water heating 21 p0137 A79-17466
- Space heating with solar all-air systems - CSU Solar House II 21 p0137 A79-17467
- Conceptual development of a solar town in Iran 21 p0138 A79-17469
- Some experimental investigations on solar space heating in Korea 21 p0138 A79-17470
- Design of a low-energy house in Denmark heated by a combination of solar and wind energy 21 p0138 A79-17471
- Simulation and design of evacuated tubular solar residential air conditioning systems and comparison with actual performance 21 p0138 A79-17475
- Solar heated and cooled financial building 21 p0139 A79-17484
- Solar retrofitting of existing residence with almost zero delta TE system 21 p0139 A79-17485
- Solar heating for a novel dwelling independent of servicing networks 21 p0140 A79-17492
- An earth-wrapped solar greenhouse house --- partially buried structure 21 p0140 A79-17493
- Enhancement of intrinsic solar heating --- thermal performance of house design option 21 p0140 A79-17494
- Experimental investigation on solar house heating in northern India 21 p0140 A79-17495
- Performance evaluation of the New Mexico State University Solar House [ASME PAPER 78-WA/SOL-8] 21 p0163 A79-19840
- A Thermic Controller for a thermic diode solar panel [ASME PAPER 78-WA/SOL-9] 21 p0163 A79-19841
- The application of thermography to large arrays of solar energy collectors 22 p0242 A79-21171
- Investigations of solar heat production for household heating in Turkey 22 p0253 A79-22265
- Optimum collector slope for residential heating in adverse climates 22 p0263 A79-23761
- Solar energy and heat insulation --- materials for residential buildings 22 p0268 A79-24321
- Solar storage unit with built-in oil-gas boiler 22 p0268 A79-24322
- What and where - Solar active systems or energy conservation in buildings 22 p0275 A79-25927
- Passive solar heating of buildings 22 p0275 A79-25928
- The CCMS solar energy pilot study system performance reporting format 22 p0275 A79-25930
- Solar heating, cooling and hot water production - A critical look at CCMS installations 22 p0275 A79-25931
- Solar air heating and nocturnal cooling system /CSU Solar House II/ 22 p0275 A79-25932
- Dornier/BWE solar house in Essen, FRG 22 p0276 A79-25933
- Experience with the MBB-solar testing house at Otterfing and relevant consequences on the commercial product 22 p0276 A79-25934
- Mississauga solar house /Mississauga, Ontario, Canada/ 22 p0276 A79-25935
- Thomson Solar House I 22 p0276 A79-25936
- Solar houses in Blagnac /Blagnac, Haute-Garonne, France/ 22 p0276 A79-25937
- The performance of the heating system in the solar house of the Eindhoven University of Technology 22 p0276 A79-25938
- Performance of residential solar heating and cooling system with flat-plate and evacuated tubular collectors - CSU Solar House I 22 p0276 A79-25939
- CCMS solar energy pilot study reporting format - The zero energy house in Denmark 22 p0277 A79-25940
- The Philips experimental house - A system's performance study --- of solar energy utilization and energy conservation 22 p0277 A79-25941
- Passive solar heating system in Turkey 22 p0277 A79-25942
- Passive solar house in Vethlanda - Interim report 22 p0277 A79-25943
- Solar heating and cooling performance of the Los Alamos National Security and Resources Study Center 22 p0277 A79-25944
- Santa Clara Community Center Project, USA --- solar building 22 p0277 A79-25945
- The Tritherm test house --- solar heating experiment 22 p0290 A79-27723
- Passive solar energy design and materials --- Book 22 p0302 A79-29625
- Case history - Hybrid passive/active solar system: Performance and cost 22 p0313 A79-31315
- The Saskatchewan Conservation House - Some preliminary performance results 22 p0318 A79-31417
- NRC solar monitoring program 22 p0318 A79-31419
- Performance of the Meadowvale solar home 22 p0318 A79-31420
- Off-peak electrical backup experience in the Meadowvale Solar Experiment 22 p0318 A79-31421
- New approaches for the appropriate use of solar energy in northern climates 22 p0319 A79-31424
- Component cost of solar energy systems 22 p0319 A79-31429
- Energy management through energy conservation in buildings 22 p0320 A79-31431
- Design study on solar energy systems for commercial buildings 22 p0320 A79-31433
- Solar energy retrofit system for an older-type building - The Williamstown Museum project 22 p0320 A79-31434
- South wall solar collector with active collector system 22 p0320 A79-31436

# SUBJECT INDEX

# SOLAR REFLECTORS

- Economic design of a solar domestic water heating system 22 p0321 A79-31438
- Validation of an electric circuit model of a solar house 22 p0321 A79-31440
- Mathematical modelling of passive solar systems 22 p0321 A79-31441
- Passive solar heating - Results from two Saskatchewan residences 22 p0322 A79-31444
- Integration of a passive and active solar heated, low density, multiple dwelling with atrium 22 p0322 A79-31446
- First year performance data and lessons learned in the NRC 14 house solar demonstration program 22 p0323 A79-31453
- Determination of the potential for solar retrofitting in Edmonton --- pilot systems for single family dwellings 22 p0323 A79-31456
- Solar heating of domestic hot water at the Confederation Heights Cafeteria 22 p0323 A79-31457
- Evaluation of high performance evacuated tubular collectors in a residential heating and cooling system: Colorado State University Solar House 1 [COO-2577-14] 21 p0206 A79-13507
- Environmental and safety considerations for solar heating and cooling applications [PB-287772/8] 22 p0343 A79-17350
- Buildings energy use data book, edition 1 [ORNL-5363] 22 p0348 A79-18447
- System integration of marketable subsystems --- for residential solar heating and cooling [NASA-CR-161104] 22 p0348 A79-18448
- Preliminary design package for residential heating/cooling system: Rankine air conditioner redesign [NASA-CR-150871] 22 p0354 A79-19453
- Final system instrumentation design package for Decade 80 solar house [NASA-CR-150869] 22 p0354 A79-19455
- SOLAR INSTRUMENTS**
- Calibration standards and field instruments for the precision measurement of insolation 21 p0076 A79-14765
- Sensor selection and placement in the National Solar Data Program 21 p0089 A79-15844
- Testing of solar collectors according to ASHRAE Standard 93-77 21 p0101 A79-16417
- Design of radiometer for measurement of total and net exchange solar radiation 21 p0119 A79-17307
- SOLAR PONDS (HEAT STORAGE)**
- Solar pond stability experiments 21 p0042 A79-11878
- Some studies on an experimental solar pond 21 p0131 A79-17416
- Yield of ground storage of heat in solar ponds 21 p0133 A79-17429
- Viscosity stabilized solar ponds 21 p0133 A79-17430
- Conditions for absolute stability of salt gradient solar ponds 21 p0133 A79-17431
- Computer simulation of the performance of a solar pond in the southern part of Iran 21 p0133 A79-17432
- Solar ponds. Citations from the NTIS data base [NTIS/PS-78/0836/3] 21 p0176 A79-10553
- Solar ponds. Citations from the engineering index data base [NTIS/PS-78/0837/1] 21 p0176 A79-10554
- Design guide for shallow solar ponds [UCRL-52385] 21 p0185 A79-11497
- Final system instrumentation design package for Decade 80 solar house [NASA-CR-150869] 22 p0354 A79-19455
- SOLAR POSITION**
- Sun-position diagrams using examples from Flensburg to Mittenwald 21 p0055 A79-13626
- Long-term average performance of the Sunpak evacuated-tube collector 21 p0089 A79-15854
- Solar energy diagrams --- combining position and insolation data 22 p0253 A79-22267
- SOLAR PROPULSION**
- A high temperature Rankine binary cycle for ground and space solar engine applications 21 p0108 A79-16613
- SOLAR RADIATION**
- A theoretical method for the prediction of monthly mean solar radiation parameters 21 p0022 A79-10183
- Results of measurements of solar radiation on surfaces of different orientations 21 p0055 A79-13622
- Measurement of radiation intensity by means of a pyrheliometer 21 p0055 A79-13623
- Irradiances on inclined surfaces --- from solar and sky radiation and earth albedo 21 p0055 A79-13624
- The use of a sort of slide rule for the quick determination of solar irradiation of surfaces and through double glazing of arbitrary orientation and different inclination 21 p0055 A79-13625
- Estimating hourly solar radiation for one-axis tracking focusing collectors 21 p0071 A79-14678
- A probabilistic model of insolation for the Mojave desert-area 21 p0076 A79-14766
- Measurement of solar radiation for energy conversion 21 p0119 A79-17305
- Design of radiometer for measurement of total and net exchange solar radiation 21 p0119 A79-17307
- Fundamentals of mathematical modeling of solar-radiation regime energy structure 21 p0166 A79-20352
- Differential insolation and turbidity measurements --- solar radiation attenuation by aerosols 22 p0241 A79-21056
- Diffuse solar radiation on a horizontal surface for a clear sky 22 p0242 A79-21167
- Solar radiation charts, --- monthly average insolation 22 p0263 A79-23763
- Selected ordinates for total solar radiant property evaluation from spectral data 22 p0271 A79-25060
- On the use of synoptic weather map typing to define solar radiation regimes 22 p0272 A79-25392
- Radiation regime of inclined surfaces --- Russian book on solar energy engineering and microclimatology 22 p0282 A79-26353
- Statistical analysis of solar radiation data in Montreal for solar energy utilization 22 p0322 A79-31452
- Radiation regime of inclined surfaces [NMO-467] 21 p0192 A79-11613
- Characterization of solar cells for space applications. Volume 4: Electrical characteristics of Spectrolab BSP 200-micron Helios cells as a function of intensity and temperature [NASA-CR-157934] 21 p0195 A79-12543
- SOLAR RADIATION SHIELDING**
- Selective covers for natural cooling devices --- in space 22 p0272 A79-25522
- SOLAR REFLECTORS**
- Enhanced solar energy options using earth-orbiting mirrors 21 p0019 A79-10162
- Specular mirrors for solar energy application 21 p0034 A79-11147
- Solar thermal power systems point-focusing distributed receiver /PPDR/ technology - a project description [AIAA PAPER 78-1771] 21 p0062 A79-13869
- Orbiting mirrors for terrestrial energy supply 21 p0108 A79-16605
- Solar thermal collectors using planar reflector 21 p0131 A79-17412

- Performance of optimal geometry three step compound wedge stationary concentrator --- solar collector using flat side mirrors 21 p0134 A79-17438
- Comparative performance of tracking type and non-tracking type solar collectors 21 p0136 A79-17454
- A reflector concentrator modified sterling engine unit and an aqua-ammonia absorber gas turbine unit for farm power needs 21 p0142 A79-17509
- Optimal geometries for one- and two-faced symmetric side-wall booster mirrors --- for solar collectors 21 p0149 A79-18019
- A cavity receiver design for solar heated gas turbine generating systems [ONERA, TP NO. 1978-137] 21 p0155 A79-18560
- The thermomechanical behavior of polyvinyl butyral film and its effect on focal stability of a solar mirror-laminate 22 p0239 A79-20824
- Space reflector technology and its system implications [AIAA PAPER 79-0545] 22 p0273 A79-25852
- Linear echelon refractor/reflector solar concentrators 22 p0293 A79-28143
- A parabolic solar reflector for accurate and economic producibility 22 p0293 A79-28145
- Analysis of a Cassegrain solar furnace 22 p0293 A79-28147
- Specularity measurements for solar materials 22 p0294 A79-28153
- Optical analysis of solar facility heliostats 22 p0296 A79-28360
- Primary reflector for solar energy collection systems [NASA-CASP-NPO-13579-4] 21 p0217 A79-14529
- The parabolic concentrating collector: A tutorial [NASA-CR-158246] 22 p0359 A79-20491
- SOLAR SAILS**
- Advanced composites - Future space applications 21 p0086 A79-15504
- Earth orbital assessment of solar electric and solar sail propulsion systems [NASA-CR-158167] 22 p0345 A79-17898
- SOLAR SENSORS**
- Effects of pointing errors on receiver performance for parabolic dish solar concentrators 21 p0020 A79-10167
- Computer based sun following system 22 p0242 A79-21165
- Solar tracking control system Sun Chaser [NASA-TN-78199] 21 p0172 A79-10514
- SOLAR SIMULATION**
- Measurement and modelling of shortwave radiation on inclined surfaces 22 p0242 A79-21062
- Modeling, simulation, testing, and measurements for solar energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978 22 p0266 A79-24309
- Solar system modeling using a modular approach with generalized programs for working fluid properties 22 p0266 A79-24310
- A computer simulation model for determining preferred solar heating and cooling systems 22 p0267 A79-24313
- SOLAR SIMULATORS**
- Solar radiation simulation by means of solar simulator for the indoor testing of solar collectors 21 p0055 A79-13620
- Proposal for efficient appreciation of solar thermal absorptive materials by high irradiance solar simulator 21 p0130 A79-17406
- SOLENOIDS**
- Design criteria for multilayer superconductive magnets 22 p0236 A79-20536
- Self-consistent analysis of alpha-particle heating of a fast-solenoid plasma --- in laser fusion 22 p0291 A79-27879
- SOLID ELECTRODES**
- Semiconductor electrodes for conversion and storage of solar energy 21 p0036 A79-11777
- Iron oxide semiconductor electrodes in photoassisted electrolysis of water 21 p0037 A79-11781
- A study of positive electrode materials for batteries operating in a halide-aluminate medium 22 p0245 A79-21480
- Casing materials for sodium/sulfur cells 22 p0245 A79-21481
- SOLID SOLUTIONS**
- High temperature thermodynamics of the solid solutions of hydrogen and deuterium in palladium and in the Pd/0.9/Ag/0.1/ alloy 22 p0249 A79-21689
- SOLID STATE DEVICES**
- Present status of GaAs --- including space processing and solid state applications [NASA-CR-3093] 21 p0215 A79-14192
- SOLID WASTES**
- Environmental effects of burning solid waste as fuel 21 p0082 A79-15115
- Energy from urban waste 21 p0096 A79-15917
- Solid waste and coal firing in industrial boilers 21 p0096 A79-15918
- Corrosion and deposits from combustion of solid waste. VI - Processed refuse as a supplementary fuel in a stoker-fired boiler [ASME PAPER 78-WA/FU-4] 21 p0160 A79-19788
- Modern technology for recovering energy and materials from urban wastes - Its applicability in developing countries 22 p0295 A79-28183
- Utilisation of solid waste 22 p0304 A79-30204
- Sensible heat storage for solar energy applications 22 p0322 A79-31449
- Assessment of the solid waste impact of the National Energy Plan [BNL-50708] 21 p0213 A79-13572
- Antimony, arsenic, and mercury in the combustible fraction of municipal solid waste [PB-285196/2] 21 p0213 A79-13590
- A methodology for evaluating the potential materials and energy recovery from municipal solid waste 21 p0215 A79-13935
- Engineering and economic analysis of waste to energy systems [PB-285797/7] 21 p0224 A79-14946
- Test procedures for the determination of the gross caloric value of refuse and refuse-derived-fuels by oxygen bomb calorimetry: Summary of the 1977 fiscal year results [PB-290160/1] 22 p0364 A79-21167
- Energy conservation through source reduction [PB-290126/2] 22 p0372 A79-21626
- Pollution control guidelines for coal refuse piles and slurry ponds [PB-291369/7] 22 p0373 A79-21682
- SOLID-SOLID INTERFACES**
- On the role of interface states in MOS solar cells 21 p0156 A79-19092
- The interfacial layer in MIS amorphous silicon solar cells 22 p0258 A79-23039
- A regenerative process for fluidized-bed combustion of coal with lime additives 22 p0297 A79-28984
- SOLIDS**
- Evaluation and optimization of Solid Polymer Electrolyte (SPE) fuel cells [AD-A058380] 21 p0206 A79-13505
- SOLIDS FLOW**
- Continuous extrusion of coal --- plastic fluidizing process 22 p0282 A79-26372
- SOLVENT EXTRACTION**
- Operation of the Ft. Lewis, Washington Solvent Refined Coal /SRC/ Pilot Plant in the SRC I and SRC II processing modes 21 p0006 A79-10054
- Exxon Donor Solvent coal liquefaction process development 21 p0007 A79-10060

# SUBJECT INDEX

# SPACE INDUSTRIALIZATION

- Coal-based electricity and air pollution control -  
A case for solvent refined coal 21 p0096 A79-15922
- Bituminous coal extraction in terms of  
electron-donor and -acceptor interactions in the  
solvent/coal system 22 p0283 A79-26469
- SOLVENTS**  
Standards of Practice Manual for the solvent  
refined coal liquefaction process  
[ASME PAPER 79-GT-67] 21 p0178 A79-10595
- SOOT**  
Role of aromatics in soot formation 21 p0053 A79-12988
- Soot and the combined cycle boiler  
[ASME PAPER 79-GT-67] 22 p0307 A79-30533
- SORBENTS**  
Evaluation of dry sorbents and fabric filtration  
for PGD (Flue Gas Desulfurization)  
[PB-289921/9] 22 p0373 A79-21661
- SORPTION**  
Efficiency improvement by means of multicomponent  
processes - Improvement of the efficiency of  
heat-power transformation by means of an  
employment of Clausius-Rankine sorption processes  
21 p0164 A79-19975
- Hydrogen sorption properties in binary and  
pseudobinary intermetallic compounds 22 p0250 A79-21702
- SOUTH AFRICA**  
Coal preparation design for export markets, with  
particular reference to South African and  
Canadian coals 22 p0340 A79-17318
- Coal gasification and South Africa 22 p0340 A79-17321
- Energy requirements for producing steel in the  
Republic of South Africa 22 p0340 A79-17322
- Low-temperature application of solar energy in  
South Africa 22 p0340 A79-17324
- The planning and economic aspects of energy supply  
and demand in South Africa 22 p0341 A79-17325
- Energy today and tomorrow 22 p0341 A79-17326
- SOUTH AMERICA**  
Solar energy in Latin America - An overview  
21 p0116 A79-17279
- SPACE COLONIES**  
Statement of Doctor Klaus Reiss, President, ECON,  
Incorporated, Princeton, New Jersey 21 p0224 A79-15110
- SPACE COMMUNICATION**  
Optical coatings for a space laser communications  
system 22 p0292 A79-28028
- SPACE ERECTABLE STRUCTURES**  
Construction of a 10GWe solar power satellite  
21 p0003 A79-10029
- Space platforms for building large space structures  
21 p0032 A79-10511
- Structures for solar power satellites  
21 p0032 A79-10513
- SPACE EXPLORATION**  
The application of solar thermoelectric generators  
in near-sun missions 21 p0023 A79-10187
- SPACE HEATING (BUILDINGS)**  
A solar energy system for space heating and space  
cooling --- retrofitting aged buildings 21 p0072 A79-14686
- System performance measurements for a packaged  
solar space heating system equipped with  
air-heating collectors 21 p0088 A79-15835
- Long-term storage of solar energy in native rock  
21 p0120 A79-17314
- Experiments in solar space heating and cooling for  
moderately insulated regions 21 p0137 A79-17464
- Space heating with solar all-air systems - CSU  
Solar House II 21 p0137 A79-17467
- Solar energy and heat insulation --- materials for  
residential buildings 22 p0268 A79-24321
- A test bed for thermosyphon solar air collectors  
[AIAA PAPER 79-0541] 22 p0274 A79-25860
- Passive solar heating of buildings 22 p0275 A79-25928
- Solar air heating and nocturnal cooling system  
/CSU Solar House II/ 22 p0275 A79-25932
- Passive solar house in Vetlanda - Interim report  
22 p0277 A79-25943
- Solar heating and cooling performance of the Los  
Alamos National Security and Resources Study  
Center 22 p0277 A79-25944
- Design considerations for residential solar  
heating and cooling systems utilizing evacuated  
tube solar collectors 22 p0285 A79-26815
- The Trithem test house --- solar heating experiment  
22 p0290 A79-27723
- Economic feasibility of solar water and space  
heating 22 p0292 A79-27899
- A Markov model of solar energy space and hot water  
heating systems 22 p0295 A79-28353
- Heat pump technology for saving energy --- Book  
22 p0302 A79-29624
- Case history - Hybrid passive/active solar system:  
Performance and cost 22 p0313 A79-31315
- The Saskatchewan Conservation House - Some  
preliminary performance results 22 p0318 A79-31417
- Off-peak electrical backup experience in the  
Meadowdale Solar Experiment 22 p0318 A79-31421
- The performance of a site built, air heating,  
vertical collector with snow reflector in Quebec  
22 p0319 A79-31423
- New approaches for the appropriate use of solar  
energy in northern climates 22 p0319 A79-31424
- Allowable costs for alternative domestic heating  
systems using utility supplied electricity for  
backup or charging energy 22 p0319 A79-31428
- Energy management through energy conservation in  
buildings 22 p0320 A79-31431
- Solar heating and ventilation using the modified  
Trombe wall system 22 p0320 A79-31435
- South wall solar collector with active collector  
system 22 p0320 A79-31436
- Cost analysis and optimization study for solar  
heating and cooling systems, Stillwater,  
Minnesota and Newcastle, Pennsylvania  
[NASA-CR-161201] 22 p0358 A79-20478
- Cost analysis and optimization study for solar  
heating and cooling systems  
[NASA-CR-161200] 22 p0360 A79-20499
- SPACE INDUSTRIALIZATION**  
Advanced composites - Future space applications  
21 p0086 A79-15504
- Space Congress, 15th, Cocoa Beach, Fla., April  
26-28, 1978, Proceedings 21 p0099 A79-16126
- Large-scale human benefits from the  
industrialization of space 21 p0099 A79-16136
- Economic opportunities of space enterprise in the  
next decades 21 p0100 A79-16137
- A technology program for large area space systems  
21 p0100 A79-16145
- Future space transportation systems 21 p0100 A79-16146
- Overview of future programs - USA --- manned  
orbital space missions 21 p0116 A79-17275
- Statement of Doctor Krafft A. Ehrlicke, President,  
Space Global, La Jolla, California 21 p0224 A79-15108
- Statement of Doctor Klaus Reiss, President, ECON,  
Incorporated, Princeton, New Jersey 21 p0224 A79-15110

## SPACE LAW

Solar energy and the 'Common Heritage of Mankind'  
 --- international agreements regarding usage  
 [IAF PAPER 78-SL-45] 21 p0035 A79-11356  
 Solar energy via satellites and international  
 cooperation 22 p0310 A79-30952

## SPACE MAINTENANCE

Health maintenance and health surveillance  
 considerations for an SPS space construction  
 base community [AAS PAPER 78-176] 22 p0243 A79-21273  
 Satellite power system: Concept development and  
 evaluation program, reference system report  
 [NASA-TM-80413] 22 p0367 A79-21538

## SPACE MANUFACTURING

The utilization of European space techniques for  
 energy production [IAF PAPER 78-190] 21 p0035 A79-11287  
 On-orbit fabrication and assembly of large space  
 structural subsystems [IAF PAPER 78-192] 21 p0035 A79-11288  
 Space will be the next big construction site  
 22 p0268 A79-24450

## SPACE MISSIONS

Ultralow-mass solar-array designs for Halley's  
 comet rendezvous mission 21 p0020 A79-10169  
 Selenide isotope generator for the Galileo mission  
 21 p0022 A79-10185  
 Symposium on the Future of Space Science and Space  
 Applications [GPO-23-876] 21 p0224 A79-15105  
 Statement of Ivan Bekey, Director of Advanced  
 Mission Studies, Aerospace Corporation  
 21 p0224 A79-15107  
 Statement of Doctor Klaus Heiss, President, ECON,  
 Incorporated, Princeton, New Jersey  
 21 p0224 A79-15110  
 OAST Space Theme Workshop. Volume 1: Summary  
 report. 1: Introduction. 2: General  
 observations and some key findings. 3:  
 Follow-on activity. Quick-look comments and  
 working papers [NASA-TM-80001] 21 p0224 A79-15113  
 OAST Space Theme Workshop. Volume 2: Theme  
 statement. 1: Space power (no. 7). A. Theme  
 statement. B. 26 April 1976 presentation. C.  
 Summary. D. Initiative action [NASA-TM-80002] 21 p0225 A79-15114  
 OAST Space Theme Workshop. Volume 3: Working  
 group summary. 6: Power (P-2). A. Statement.  
 B. Technology needs (form 1). C. Priority  
 assessment (form 2) [NASA-TM-80013] 21 p0225 A79-15125  
 Primary lithium battery technology and its  
 application to NASA missions [NASA-CR-158229] 22 p0354 A79-19449

**SPACE POWER REACTORS**  
 Space power technology - Current status and future  
 development trends --- for powering spacecraft  
 [DGLR PAPER 78-167] 21 p0063 A79-14054  
 Radiation energy conversion in space  
 22 p0284 A79-26595  
 Mini-Brayton heat source assembly development  
 [NASA-CR-159447] 21 p0196 A79-12554

**SPACE PROCESSING**  
 Feasibility of rocket propellant production on Mars  
 21 p0047 A79-12324  
 Present status of GaAs --- including space  
 processing and solid state applications  
 [NASA-CR-3093] 21 p0215 A79-14192

**SPACE PROGRAMS**  
 Large-scale human benefits from the  
 industrialization of space 21 p0099 A79-16136  
 Economic opportunities of space enterprise in the  
 next decades 21 p0100 A79-16137  
 Symposium on the Future of Space Science and Space  
 Applications [GPO-23-876] 21 p0224 A79-15105  
 United States civilian space programs: An overview  
 [GPO-35-823] 21 p0232 A79-15815  
 Authorizing appropriations to the National  
 Aeronautics and Space Administration  
 [H-REPT-96-52] 22 p0364 A79-20928

## SPACE RENDEZVOUS

Ultralow-mass solar-array designs for Halley's  
 comet rendezvous mission 21 p0020 A79-10169

## SPACE SHUTTLE ORBITERS

Assessment of SEPS solar array technology for  
 orbital service module application  
 [NASA-CR-151859] 21 p0194 A79-12136

## SPACE SHUTTLE PAYLOADS

The 25 kW power module evolution study. Part 3:  
 Conceptual designs for power module evolution.  
 Volume 2: Program plans [NASA-CR-161146] 22 p0345 A79-17890

## SPACE SHUTTLES

Cooling radioisotope thermoelectric generators in  
 the Shuttle 21 p0023 A79-10186  
 Roll-out solar arrays - Candidate power sources  
 for future space missions [IAF PAPER 78-39] 21 p0034 A79-11216  
 Evolution of space power systems [IAF PAPER 78-43] 21 p0035 A79-11218  
 Flexible roll-out solar generators - Energy  
 sources for future high-power space missions  
 [DGLR PAPER 78-165] 21 p0063 A79-14056  
 Space Shuttle - America's wings to the future ---  
 Book 21 p0114 A79-17124  
 Study on solar arrays for programmes leading from  
 the extension of Spacelab towards space platforms  
 [ESS/SS-878] 22 p0335 A79-16379  
 Hydrogen embrittlement and its control in  
 hydrogen-fueled engine systems 22 p0366 A79-21429

## SPACE STATIONS

Manned remote work station development article  
 [NASA-CR-151871] 22 p0330 A79-16057  
 Study on solar arrays for programmes leading from  
 the extension of Spacelab towards space platforms  
 [ESS/SS-878] 22 p0335 A79-16379  
 The 100 kW space station --- regenerative fuel  
 cells and nickel hydrogen and nickel cadmium  
 batteries for solar arrays 22 p0371 A79-21603  
 The 25 kW space station 22 p0371 A79-21604

## SPACE TRANSPORTATION

Space Congress, 15th, Cocoa Beach, Fla., April  
 26-28, 1978, Proceedings 21 p0099 A79-16126  
 The 25 kW power module updated baseline system ---  
 for space transportation system payloads  
 [NASA-TM-78212] 21 p0226 A79-15247

## SPACE TRANSPORTATION SYSTEM

Future space transportation systems 21 p0100 A79-16146  
 Space Shuttle - America's wings to the future ---  
 Book 21 p0114 A79-17124  
 Overview of future programs - USA --- manned  
 orbital space missions 21 p0116 A79-17275  
 Satellite Power Systems (SPS) concept definition  
 study (exhibit C) [NASA-CR-150827] 21 p0183 A79-11475  
 Satellite Power Systems (SPS) concept definition  
 study. Volume 5: Transportation and operations  
 analysis --- heavy lift launch and orbit  
 transfer vehicles for orbital assembly  
 [NASA-CR-158067] 21 p0225 A79-15139  
 The 25 kW power module evolution study. Part 3:  
 Conceptual designs for power module evolution.  
 Volume 2: Program plans [NASA-CR-161146] 22 p0345 A79-17890

**SPACECRAFT CONFIGURATIONS**  
 Transient attitude dynamics of satellites with  
 deploying flexible appendages 21 p0047 A79-12325

**SPACECRAFT CONSTRUCTION MATERIALS**  
 Advanced composites - Future space applications  
 21 p0086 A79-15504

**SPACECRAFT CONTROL**  
 Spatial oscillations of a solid body carrying a  
 low-power flywheel motor --- dual spin  
 spacecraft motion control 21 p0148 A79-17792

# SUBJECT INDEX

# SPARK IGNITION

## SPACECRAFT DESIGN

New design verification aspects of large flexible solar arrays  
[IAP PAPER 78-217] 21 p0035 A79-11298  
Space Shuttle - America's wings to the future --- Book 21 p0114 A79-17124

## SPACECRAFT POWER SUPPLIES

Silver-hydrogen, a long life light weight energy storage system --- design for spacecraft 21 p0001 A79-10012  
Vertical junction silicon solar cell --- for spacecraft power sources 21 p0001 A79-10013  
The NTS-2 satellite solar cell experiment 21 p0001 A79-10016  
Orbiting Solar Observatory /OSO-8/ solar panel design and in-orbit performance 21 p0001 A79-10017  
Intelsat V solar array design and development summary 21 p0002 A79-10018  
Design features of the TDRSS solar array --- Tracking and Data Relay Satellites 21 p0002 A79-10019  
Ultralow-mass solar-array designs for Halley's comet rendezvous mission 21 p0020 A79-10169  
Selenide isotope generator for the Galileo mission 21 p0022 A79-10185  
Cooling radioisotope thermoelectric generators in the Shuttle 21 p0023 A79-10186  
The application of solar thermoelectric generators in near-sun missions 21 p0023 A79-10187  
Copper/water axially-grooved heat pipes for RTG applications 21 p0023 A79-10188  
Brayton Isotope Power System - The versatile dynamic power converter --- for spacecraft 21 p0023 A79-10190  
Melting multifoil insulation for KIPS emergency cooling --- Kilowatt Isotope Power System 21 p0023 A79-10191  
Prospects of thermionic power systems 21 p0026 A79-10220  
Selenide technology evaluation program at JPL 21 p0026 A79-10222  
Proposals for power conditioning systems of high power communication satellites 21 p0033 A79-10897  
Advancements in the design of solar array to battery charge current regulators 21 p0033 A79-10902  
Roll-out solar arrays - Candidate power sources for future space missions [IAP PAPER 78-39] 21 p0034 A79-11216  
Radioisotope-powered free-piston Stirling engine for space applications [IAP PAPER 78-42] 21 p0034 A79-11217  
Evolution of space power systems [IAP PAPER 78-43] 21 p0035 A79-11218  
A problem of optimizing the setting angle of sun-battery panels of concave shape --- onboard satellite 21 p0045 A79-12186  
High efficiency low cost solar cell power 21 p0048 A79-12471  
Space power technology - Current status and future development trends --- for powering spacecraft [DGLR PAPER 78-167] 21 p0063 A79-14054  
Flexible roll-out solar generators - Energy sources for future high-power space missions [DGLR PAPER 78-165] 21 p0063 A79-14056  
Space power for space 21 p0100 A79-16143  
Energy storage requirements for spacecraft 22 p0246 A79-21486  
Design concepts of solar thermoelectric generators in space applications 22 p0260 A79-23612  
Enhanced power generation by optical solar reflectors on geostationary spinners 22 p0272 A79-25138  
Study of the characteristics of Ni-Cd storage batteries for space applications 22 p0304 A79-30207

Future large space systems opportunities: A case for space-to-space power? --- spacecraft power supplies microwave and laser transmission 21 p0169 A79-10095  
Future Orbital Power Systems Technology Requirements [NASA-CP-2058] 21 p0169 A79-10122  
OAST space power technology program 21 p0169 A79-10123  
Historical and projected power requirements 21 p0169 A79-10125  
Military needs for orbital power 21 p0169 A79-10127  
Satellite power systems program 21 p0169 A79-10128  
Power management and control for space systems 21 p0170 A79-10134  
An economical approach to space power systems 21 p0170 A79-10139  
Battery workshop 21 p0170 A79-10143  
Assessment of SEPS solar array technology for orbital service module application [NASA-CR-151859] 21 p0194 A79-12136  
OAST Space Theme Workshop. Volume 2: Theme summary. 1: Space power (no. 7). A. Theme statement. B. 26 April 1976 presentation. C. Summary. D. Initiative action [NASA-TN-80002] 21 p0225 A79-15114  
OAST Space Theme Workshop. Volume 3: Working group summary. 6: Power (P-2). A. Statement. B. Technology needs (form 1). C. Priority assessment (form 2) [NASA-TN-80013] 21 p0225 A79-15125  
Study on solar arrays for programmes leading from the extension of Spacelab towards space platforms [ESS/SS-878] 22 p0335 A79-16379  
The 1977 Goddard Space Flight Center Battery Workshop [NASA-CP-2041] 22 p0370 A79-21565  
Synchronous meteorological and geostationary operational environmental satellites battery and power system design 22 p0370 A79-21571

## SPACECRAFT PROPULSION

A summary of USSR thermionic energy conversion activity 21 p0026 A79-10216  
NASA's thermionic technology program 21 p0026 A79-10217  
Space power for space 21 p0100 A79-16143  
Radiation energy conversion in space; Conference, 3rd, NASA Ames Research Center, Moffett Field, Calif., January 26-28, 1978, Technical Papers 21 p0107 A79-16601  
A high temperature Rankine binary cycle for ground and space solar engine applications 21 p0108 A79-16613  
Laser-powered aircraft and rocket systems with laser energy relay units 21 p0109 A79-16619  
Microwave power transmitting phased array antenna research project [NASA-CR-157843] 21 p0202 A79-13263

## SPACECRAFT STRUCTURES

Satellite Power System (SPS) concept definition study (exhibit C) [NASA-CR-150733] 21 p0225 A79-15137

## SPACELAB

Flexible roll-out solar generators - Energy sources for future high-power space missions [DGLR PAPER 78-165] 21 p0063 A79-14056  
Study on solar arrays for programmes leading from the extension of Spacelab towards space platforms [ESS/SS-878] 22 p0335 A79-16379

## SPACING

Shading and spacing in paraboloidal collector arrays 21 p0150 A79-18025

## SPARK IGNITION

Some problems and benefits from the hydrogen fueled spark ignition engine 21 p0016 A79-10130  
A one-dimensional combustion model for a dual chamber stratified charge spark ignition engine [SAP PAPER 790355] 22 p0315 A79-31371  
Variable-displacement spark-ignition engine [SAND-77-8299] 21 p0172 A79-10435

# SPATIAL DEPENDENCIES

- Tests of Wisconsin S12D engine running on natural gas with addition of carbon dioxide  
[AD-A058486] 22 p0339 A79-17230
- SPATIAL DEPENDENCIES**  
Space-dependent thermal stability of reacting tokamak plasmas 22 p0253 A79-22242
- SPECIFIC HEAT**  
Transient energy removal in cylindrical parabolic collector systems 21 p0020 A79-10168  
Some aspects of the transient response of a flat-plate solar energy collector 21 p0153 A79-18466  
Analysis of a cylindrical imploding shock wave 21 p0155 A79-18846  
Specific heat variations in oil energy storage media and their economic implications  
[SAND-78-8672] 21 p0189 A79-11537
- SPECIFICATIONS**  
Effect of broadened-specification fuels on aircraft engines and fuel systems  
[NASA-TN-79086] 22 p0330 A79-16136
- SPECTRAL CORRELATION**  
Observation of voltage fluctuations in a Superconducting Magnet during MHD power generation 22 p0235 A79-20531
- SPECTRAL ENERGY DISTRIBUTION**  
Spectral characteristics of photoconverters with nonuniform defect distribution in the base 21 p0053 A79-13289  
Multicolor solar cell power system for space 21 p0108 A79-16611  
Selected ordinates for total solar radiant property evaluation from spectral data 22 p0271 A79-25060
- SPECTRAL REFLECTANCE**  
Investigation and perspectives on iron oxide, zinc conversion coating, zinc oxide, cobalt oxide and tungsten oxide as spectral selective solar absorber surfaces 21 p0126 A79-17375  
Selective absorption of solar energy in ultrafine metal particles - Model calculations 22 p0273 A79-25746
- SPECTRAL SENSITIVITY**  
The measurement of optical properties of selective surfaces using a solar calorimeter 21 p0041 A79-11874  
High efficiency low cost solar cell power 21 p0048 A79-12471  
Investigation and perspectives on iron oxide, zinc conversion coating, zinc oxide, cobalt oxide and tungsten oxide as spectral selective solar absorber surfaces 21 p0126 A79-17375  
On the use of grating or mesh selective filters to increase the efficiency of flat plate solar collectors 21 p0127 A79-17380  
Selective absorption of solar energy by ultrafine metal particles 21 p0127 A79-17382  
Spectral selective properties of black chrome and nickel electrodeposited coatings for solar absorber 21 p0127 A79-17383  
The structure and properties of Cu based selective surfaces formed on an Al-Cu alloy by chemical brightening and etching treatments --- for flat plate solar collectors 21 p0127 A79-17384  
Field performance of certain selective and neutral surfaces in solar collectors 21 p0131 A79-17417  
Gold, silver, chromium, and copper cermet selective surfaces for evacuated solar collectors 22 p0256 A79-22855  
The short-wavelength response of MIS solar cells 22 p0273 A79-25748
- SPECTROSCOPY**  
Moessbauer spectroscopy of iron in coal and coal hydrogenation products 22 p0282 A79-26464
- SPECTRUM ANALYSIS**  
Study of the spectral characteristics of metallized polymer films for production of solar concentrators 22 p0297 A79-28672

# SUBJECT INDEX

- SPECULAR REFLECTION**  
Specular mirrors for solar energy application 21 p0034 A79-11147  
Optical evaluation techniques for reflecting solar concentrators 21 p0043 A79-11971  
Comparison of the solar concentrating properties of truncated hexagonal, pyramidal and circular cones 21 p0043 A79-11974  
Reflecting horizontal collector 21 p0128 A79-17395  
Augmented solar energy collection using different types of planar reflective surfaces - Theoretical calculations and experimental results 22 p0242 A79-21166  
Selective absorption of solar energy in ultrafine metal particles - Model calculations 22 p0273 A79-25746  
Specularity measurements for solar materials 22 p0294 A79-28153
- SPEED CONTROL**  
Response of lead-acid batteries to chopper-controlled discharge --- for electric vehicles 21 p0011 A79-10097  
DOE/NASA Mod-OA wind turbine performance 21 p0028 A79-10235  
On-line control of a large horizontal axis wind energy conversion system and its performance in a turbulent wind environment 21 p0028 A79-10236  
Control of wind turbine generators connected to power systems 21 p0086 A79-15574  
Operation and control of wind-electric systems 21 p0086 A79-15575  
Controlling a wind generator for increased efficiency 21 p0113 A79-16743
- SPHERES**  
P.E.R.I.C.L.E.S. - Design of a stationary spherical collector --- solar energy application 21 p0134 A79-17441  
MHD stability of Spheromak 22 p0313 A79-31189
- SPHINX**  
Radiation energy conversion in space 22 p0284 A79-26595  
Power from space by laser 22 p0284 A79-26596  
Laser aircraft --- using kerosene 22 p0284 A79-26597
- SPIN STABILIZATION**  
Enhanced power generation by optical solar reflectors on geostationary spinners 22 p0272 A79-25138
- SPIRAL WRAPPING**  
Mathematics of coiling in cylindrical electrochemical cells - The theory of a spiral bounded by two circles and its application to the spiral-wound nickel-cadmium cell 22 p0246 A79-21489
- SPRAYED COATINGS**  
Transparent conducting coatings for solar cells 21 p0124 A79-17350
- SPRINGS (WATER)**  
Suggestions for a geochemical prospecting of geothermal systems - A first survey of the Italian thermal springs 21 p0075 A79-14737  
A comparison of the silica and Na-K-Ca geothermometers for thermal springs in Utah 21 p0097 A79-16075
- SPUTTERING**  
DC reactively sputtered metal carbide and metal silicide selective absorbing surfaces --- for photothermal solar energy conversion 21 p0126 A79-17377  
Alpha transport and blistering in tokamaks 22 p0253 A79-22243
- STACKS**  
Multistack nickel-hydrogen units 22 p0371 A79-21610
- STAGNATION TEMPERATURE**  
Performance of a honeycomb type flat plate collector with serpentine tube 21 p0054 A79-13579



# SUBJECT INDEX

# STEEL STRUCTURES

## STAINLESS STEELS

- Studies on the selective absorption surface on stainless steel --- for flat type solar collectors 21 p0127 A79-17378
- Colored stainless steel - A new type of selective absorber --- for solar thermal conversion 22 p0294 A79-28150

## STANDARDS

- Federal automobile fuel economy standards - A status report 21 p0073 A79-14693
- Building energy standards and codes 21 p0073 A79-14696
- The application of ASHRAE Standard 93-77 to the thermal performance testing of air solar collectors 21 p0102 A79-16423
- An optimal standard for solar heating systems [ASME PAPER 78-WA/DSC-19] 21 p0159 A79-19765
- Plan for the development and implementation of standards for solar heating and cooling applications [PB-283237/6] 21 p0190 A79-11543
- Phase one/base data for the development of energy performance standards for new buildings. Climatic classification [PB-286900/6] 22 p0336 A79-16497
- Phase one/base data for the development of energy performance standard for new buildings. Task report: Building classification [PB-286904/8] 22 p0355 A79-19468
- Solar building regulatory study, volume 2 [PB-289824/5] 22 p0357 A79-20291
- Solar building regulatory study, volume 1 [PB-289823/7] 22 p0365 A79-21235
- Interim performance criteria for solar heating and cooling systems in residential buildings, second edition [PB-289967/2] 22 p0372 A79-21630

## STAR TRACKERS

- Dynamics of stepping of the Hermes flexible solar array 22 p0323 A79-31615
- Solar tracking control system Sun Chaser [NASA-TM-78199] 21 p0172 A79-10514

## STATIC INVERTERS

- Thyristor controlled rectifier inverting at unity power factor 21 p0033 A79-10898

## STATIC LOADS

- Libbey-Owens-Ford solar collector static load test [NASA-CR-150852] 21 p0205 A79-13494

## STATIONARY ORBITS

- Solar power satellites revisited 21 p0093 A79-15898

## STATISTICAL ANALYSIS

- On the use of synoptic weather map typing to define solar radiation regimes 22 p0272 A79-25392
- Statistical analysis of solar radiation data in Montreal for solar energy utilization 22 p0322 A79-31452
- A methodology for evaluating the potential materials and energy recovery from municipal solid waste 21 p0215 A79-13935
- Application of solar technology to today's energy needs, volume 2 --- systems analysis and analytical methods [OTA-E-77-VOL-2] 21 p0218 A79-14530
- Analytical methods 21 p0218 A79-14531
- Transportation energy conservation data book, edition 3 [ORNL-5493] 22 p0369 A79-21562

## STATISTICAL CORRELATION

- Observation of voltage fluctuations in a Superconducting Magnet during MHD power generation 22 p0235 A79-20531

## STATORS

- Test and development of ceramic combustors, stators, nose cones, and rotor tip shrouds 21 p0049 A79-12821
- Cold-air performance of free power turbine designed for 112-kilowatt automotive gas-turbine engine. 2: Effects of variable stator-vane-chord setting angle on turbine performance [NASA-TM-78993] 22 p0345 A79-17859

## Evaluation of ceramics for stator application:

- Gas turbine engine report [NASA-CR-159533] 22 p0364 A79-21075
- STEADY FLOW**
  - On the diffusive instability of some simple steady magnetohydrodynamic flows 22 p0278 A79-26163
- STEAM**
  - Energy distribution and storage alternates with a centralized heat source 21 p0013 A79-10112
  - Solar energy for industrial process steam 22 p0267 A79-24315
  - Analytical modelling of oil recovery by steam injection 22 p0358 A79-20434
- STEAM FLOW**
  - Circulating-bed boiler concepts for steam and power generation 21 p0008 A79-10071
  - The external combustion steam injected gas turbine for cogeneration 21 p0012 A79-10100
  - Steam generator and turbomachines --- MHD power plant design and Soviet operational experience 21 p0106 A79-16489
  - Performance of a 5 Mwt solar steam generator 22 p0288 A79-27399
  - Demonstration of a rotary separator for two-phase brine and steam flows [TID-28519] 22 p0365 A79-21309
- STEAM TURBINES**
  - Closed Cycle Gas Turbine power generation opportunities 21 p0004 A79-10039
  - Coal-fired gas turbine power cycles with steam injection 21 p0004 A79-10042
  - Geothermal preheating in fossil-fired steam power plants 21 p0014 A79-10118
  - Economic optimization of the coal-fired MHD Steam Power Plant 21 p0016 A79-10134
  - Reducing combustion air temperature variations in magnetohydrodynamic/steam power plants 21 p0016 A79-10135
  - Considerations for MHD power generation development 21 p0016 A79-10136
  - A proposed 40 MWe MHD pilot plant 21 p0017 A79-10137
  - Thermal modeling of coal-fired MHD plant components 21 p0017 A79-10138
  - Prospects of thermionic power systems 21 p0026 A79-10220
  - Second-generation integrated coal gasification/combined-cycle power systems [ASME PAPER 78-GT-14] 21 p0032 A79-10778
  - Magnetohydrodynamic/steam power plant modeling and control 21 p0046 A79-12274
  - A comparison of the performance of steam turbine cycles using gas contaminated geothermal steam [ASME PAPER 78-WA/ENER-3] 21 p0159 A79-19776
  - The combined reheat gas turbine/steam turbine cycle. I - A critical analysis of the combined reheat gas turbine/steam turbine cycle [ASME PAPER 79-GT-7] 22 p0306 A79-30505
  - The combined reheat gas turbine/steam turbine cycle. II - The LM 5000 gas generator applied to the combined reheat gas turbine/steam turbine cycle [ASME PAPER 79-GT-8] 22 p0306 A79-30506
  - Cylindrical parabolic collector optimization for interfacing with steam turbine generators 22 p0322 A79-31448
  - Combined cycle power generation. Citations from the HTIS data base [HTIS/PS-78/1156/5] 21 p0222 A79-14587
  - Combined cycle power generation. Citations from the Engineering Index data base [HTIS/PS-78/1157/3] 21 p0222 A79-14588
- STEEL STRUCTURES**
  - Wind turbine generator application places unique demands on tower design and materials 22 p0240 A79-20826

- STEELS**  
Energy requirements for producing steel in the Republic of South Africa 22 p0340 A79-17322
- STEERABLE ANTENNAS**  
Accuracy analysis of pointing control system of solar power station [NASA-CR-150880] 21 p0215 A79-14143
- STELLARATORS**  
Ohmic heating experiments in the W VII A stellarator 21 p0069 A79-14458  
Heating and confinement in the CIBO stellarator 21 p0070 A79-14459  
Ohmic heating experiments in the L-2 stellarator 21 p0070 A79-14460  
New results in high-beta stellarator and belt-pinch research 21 p0070 A79-14463  
Properties of the plasma ions and the particle lifetime in ohmic heating in the L-2 stellarator 22 p0244 A79-21428
- STEREOCHEMISTRY**  
The effect of maturation on the configuration of pristane in sediments and petroleum 22 p0272 A79-25375
- STIMULATED EMISSION**  
Direct conversion of solar energy into laser radiation 22 p0311 A79-31086
- STIRLING CYCLE**  
Performance of a Stirling engine powered heat activated heat pump --- gas heating-cooling system 21 p0011 A79-10098  
A computer and experimental simulation of Stirling cycle machines 21 p0023 A79-10192  
The pseudo Stirling cycle - A suitable performance criterion 21 p0023 A79-10196  
Balanced compounding of Stirling machines 21 p0024 A79-10200  
Conversion of a standard single cylinder I.C. engine into a 'gamma' configuration air charged Stirling engine 21 p0024 A79-10202  
Design of a preprototype Stirling Laboratory Research Engine 21 p0024 A79-10203  
The matching of a free piston Stirling engine coupled with a free piston linear compressor for a heat pump application 21 p0024 A79-10204  
A free-piston Stirling engine for small solar power plants 21 p0024 A79-10205  
A Stirling engine heat pump system 21 p0024 A79-10206  
Conceptual design of a variable displacement Stirling engine for automotive propulsion 21 p0025 A79-10207  
Mechanical efficiency of the Stirling cycle machine with rhombic drive 21 p0025 A79-10208  
Development of a 1 kW/e/ isotope fueled Stirling cycle power system 21 p0025 A79-10210  
Potential of the Stirling engine for stationary power applications in the 500-2000 HP range 21 p0025 A79-10211  
Status of free-piston Stirling engine/linear alternator power conversion system development 21 p0025 A79-10212  
Radioisotope-powered free-piston Stirling engine for space applications [IAEA PAPER 78-42] 21 p0034 A79-11217  
Ceramic applications in the advanced Stirling automotive engine 21 p0051 A79-12851  
A reflector concentrator modified sterling engine unit and an aqua-ammonia absorber gas turbine unit for fars power needs 21 p0142 A79-17509  
The Stirling engine, an energy converter for cogeneration applications [ASME PAPER 78-WA/ENER-4] 21 p0159 A79-19777
- Optimization and design of radiative heat-discharge system for energy unit with Stirling engine --- operating in planetary environment 21 p0166 A79-20348
- The utilization of LH2 and LNG cold for generation of electric power by a cryogenic-type Stirling engine 22 p0311 A79-31020
- Initial comparison of single cylinder Stirling engine computer model predictions with test results [SAE PAPER 790327] 22 p0315 A79-31368  
An air/fuel control system for the Stirling engine [SAE PAPER 790328] 22 p0315 A79-31369  
The Stirling engine for automotive application [SAE PAPER 790329] 22 p0315 A79-31370  
The Stirling engine for vehicle propulsion [NASA-TM-75442] 21 p0195 A79-12547  
Initial comparison of single cylinder Stirling engine computer model predictions with test results [NASA-TM-79044] 22 p0337 A79-16721  
An improved solar energy receiver for a Stirling engine [NASA-CASE-NPO-14619-1] 22 p0362 A79-20513
- STOCHASTIC PROCESSES**  
The analysis by stochastic modelling of solar systems for space and water heating 21 p0137 A79-17466  
Stochastic simulation experiments on solar air conditioning systems 21 p0138 A79-17474  
Stochastic predictions of solar cooling system performance [ASME PAPER 78-WA/SOL-16] 21 p0164 A79-19848  
Prediction of the behavior of a solar storage system by means of recurrent stochastic models --- of insolation 22 p0258 A79-23295  
Stochastic analysis of wind characteristics for energy conversion 22 p0350 A79-18535
- STOCKPILING**  
Source assessment: Water pollutants from coal storage areas [PB-285420/6] 21 p0223 A79-14635
- STOICHIOMETRY**  
Mathematical models of direct initiation of unconfined gas phase detonations --- hazards of LNG/air clouds from spills [AIAA PAPER 79-0289] 21 p0157 A79-19649
- STORAGE BATTERIES**  
Silver-hydrogen, a long life light weight energy storage system --- design for spacecraft 21 p0001 A79-10012  
Review of industrial participation in the ANL lithium/iron sulfide battery development program --- for electric vehicles 21 p0010 A79-10086  
High performance lithium/iron disulfide cells --- for electric vehicle propulsion 21 p0010 A79-10087  
Lithium silicon - Iron sulfide load-leveling and electric vehicle batteries 21 p0010 A79-10088  
Advances in the development of lithium-aluminum/metal sulfide cells for electric-vehicle batteries 21 p0010 A79-10089  
Bipolar lithium/iron disulfide cells --- for electric vehicle propulsion 21 p0010 A79-10090  
Mechanically rechargeable, metal-air batteries for automotive propulsion 21 p0011 A79-10093  
Iron-air batteries for electric vehicles 21 p0011 A79-10094  
Development and evaluation of a 600-kWh lithium-hydrogen peroxide reserve power system 21 p0011 A79-10095  
100MWh zinc-chlorine peak-shaving battery plants 21 p0011 A79-10096  
Cost minimization of photovoltaic power supplies 21 p0021 A79-10171  
Advancements in the design of solar array to battery charge current regulators 21 p0033 A79-10902

# SUBJECT INDEX

# STRUCTURAL DESIGN

- Thermodynamic and kinetic considerations on zinc-halogen batteries 21 p0040 A79-11822
- Factors affecting the open-circuit voltage and electrode kinetics of some iron/titanium/redox flow cells 21 p0040 A79-11824
- Electrochemical determinations of the chemical potential and diffusivity of sodium in Na<sub>x</sub>/TaS<sub>2</sub> at 300 K 21 p0040 A79-11830
- Electrochemistry of lithium/metal sulfide and calcium/metal sulfide cells using molten salt electrolytes 21 p0040 A79-11832
- Calcium/iron sulfide secondary cells 21 p0041 A79-11835
- Batteries for transportation and load-leveling applications 21 p0041 A79-11837
- Advanced batteries --- sodium sulfur batteries for electric motor vehicles 21 p0067 A79-14270
- Electric vehicles challenge battery technology 21 p0093 A79-15892
- Compatibility of direct energy storage devices with ac. processing power system components 21 p0111 A79-16728
- Controlling a wind generator for increased efficiency 21 p0113 A79-16743
- Saur vidyut kosh - The solar cell --- reversible charging electrolytic batteries 21 p0126 A79-17371
- On the possibility of using silver salts other than Ag<sub>2</sub>CrO<sub>4</sub> in organic lithium cells 22 p0246 A79-21491
- Electrochemical utilization of metal hydrides 22 p0251 A79-21709
- Superbatteries - A progress report --- for utility energy storage and electric vehicles 22 p0286 A79-27207
- The role of the battery electric vehicle 22 p0301 A79-29491
- Support services for electric vehicles 22 p0301 A79-29492
- Road vehicles with combined, at least partly electrical driving systems and energy supplies 22 p0301 A79-29494
- Developing electric vehicles 22 p0302 A79-29496
- An electric propulsion system for a town and city bus 22 p0302 A79-29499
- Study of the characteristics of Ni-Cd storage batteries for space applications 22 p0304 A79-30207
- Advanced secondary batteries for electric vehicle propulsion [CONF-780426-2] 21 p0186 A79-11508
- Materials for fuel cells [PB-285360/4] 21 p0212 A79-13553
- Some fatigue characteristics of nickel battery plaque [AD-A060370] 21 p0230 A79-15415
- Fabrication and testing of silver-hydrogen cells [NASA-CR-159431] 22 p0334 A79-16374
- Primary lithium battery technology and its application to NASA missions [NASA-CR-158229] 22 p0354 A79-19449
- The 1977 Goddard Space Flight Center Battery Workshop [NASA-CP-2041] 22 p0370 A79-21565
- STORAGE RINGS (PARTICLE ACCELERATORS)**
- Application of electron beams in space for energy storage and optical beam generation 21 p0108 A79-16606
- STORAGE STABILITY**
- Solar pond stability experiments 21 p0042 A79-11878
- STORAGE TANKS**
- Analysis of thermal storage unit for solar energy 21 p0122 A79-17332
- A heat operated mechanical device to control the temperature and flow of water entering a hot water storage tank in a solar water heating system 21 p0140 A79-17487
- Storage tank efficiency as simulated in a Markovian model of meteorology 22 p0254 A79-22272
- A liquid solar energy storage tank model. I - Formulation of a mathematical model 22 p0267 A79-24314
- Earth-conducted heat losses from thermal storage systems 22 p0281 A79-26208
- STRAIN ENERGY METHODS**
- Study of acoustic and microseismic emissions associated with a hydraulic fracture --- geothermal energy utilization 21 p0076 A79-14744
- STRAIN RATE**
- A new rationale for the hysteresis effects observed in metal-hydrogen systems 22 p0250 A79-21704
- STRATIFICATION**
- Stratification effects in the short and long term storage of solar heat 21 p0121 A79-17326
- STRATIFIED FLOW**
- The influence of overall equivalence ratio and degree of stratification on the fuel consumption and emissions of a prechamber, stratified-charge engine [SAE PAPER 790438] 22 p0315 A79-31375
- STREAMS**
- Coupled heat and organic wastes stream pollution 21 p0086 A79-15602
- STRESS ANALYSIS**
- Fatigue impact on Mod-1 wind turbine design 22 p0240 A79-20827
- STRIATION**
- Theory of the striated corona in a theta pinch 22 p0295 A79-28315
- STRIP MINING**
- Application of multispectral scanner data to the study of an abandoned surface coal mine [NASA-TN-78912] 21 p0204 A79-13472
- Remote monitoring of coal strip mine rehabilitation [PB-286647/3] 21 p0228 A79-15379
- Applying NASA remote sensing data to geologically related regional planning problems in Tennessee [E79-10095] 22 p0339 A79-17289
- Atlas of western surface-mined lands: Coal, uranium, and phosphate [PB-287846/0] 22 p0340 A79-17311
- STROBILIM 90**
- Recent terrestrial and undersea applications of radioisotope thermoelectric generators /RTGs/ 21 p0027 A79-10226
- Recent terrestrial and undersea applications of radioisotope thermoelectric generators /RTGs/ 22 p0261 A79-23623
- STRUCTURAL ANALYSIS**
- Analysis and application of the heat pipe heat exchanger 21 p0014 A79-10117
- Mechanical deflection analysis of diamond turned reflective optics --- for laser fusion 21 p0083 A79-15143
- Structural performance of the DOE/Sandia 17 meter vertical axis wind turbine [SAND-78-0880C] 21 p0187 A79-11516
- Vehicle Design Evaluation Program (VDEP). A computer program for weight sizing, economic, performance and mission analysis of fuel-conservative aircraft, multibodied aircraft and large cargo aircraft using both JP and alternative fuels [NASA-CR-145070] 21 p0200 A79-13026
- Thermoelastic solutions for in-situ gasification of coal 22 p0330 A79-16135
- Insulating wall boundary layer in a Faraday MHD generator [FE-23417] 22 p0365 A79-21310
- STRUCTURAL DESIGN**
- Design features of the TDRSS solar array --- Tracking and Data Relay Satellites 21 p0002 A79-10019
- Heat exchanger design for geothermal power plants 21 p0015 A79-10123
- Development and testing of the OLP solar array 21 p0029 A79-10245
- Structures for solar power satellites 21 p0032 A79-10513

# STRUCTURAL DESIGN CRITERIA

# SUBJECT INDEX

New design verification aspects of large flexible solar arrays  
[IAF PAPER 78-217] 21 p0035 A79-11298

Superconducting magnet systems in EPR designs --- Experimental Power Reactor 21 p0079 A79-14789

External single pass to superheat receiver --- for central receiver solar power plant  
[AIAA PAPER 78-1751] 21 p0089 A79-15849

SPS microwave subsystem potential impacts and benefits --- environmental and societal effects of Solar Power System construction and operation 21 p0107 A79-16603

Use of monolithic structures for the short term storage of solar energy 21 p0121 A79-17327

An earth-wrapped solar greenhouse house --- partially buried structure 21 p0140 A79-17493

Exploitation of solar energy via modular power plants and multiple utilization of waste heat 21 p0141 A79-17497

Development of 1 kW vertical axis wind generator 21 p0142 A79-17511

Structural design of a superheater for a central solar receiver  
[ASME PAPER 78-WA/PVP-1] 21 p0162 A79-19832

A superconducting dipole magnet for the UTSI MHD Facility 22 p0235 A79-20533

Practical aspects of designing and manufacturing MHD superconducting base-load magnets in 1988 time frame 22 p0235 A79-20535

The role of the Large Coil Program in the development of superconducting magnets for fusion reactors 22 p0236 A79-20541

Wind turbine generator application places unique demands on tower design and materials 22 p0240 A79-20826

Fatigue impact on Mod-1 wind turbine design 22 p0240 A79-20827

An operating 200 kW horizontal axis wind turbine 22 p0240 A79-20829

A composite-rim flywheel design 22 p0240 A79-20840

A status of the 'Alpha-ply' composite flywheel concept development 22 p0241 A79-20843

Calculation and design of liquid-metal MHD induction machines --- Russian book 22 p0286 A79-27302

Structural cost optimization of photovoltaic central power station modules and support structure  
[ASME PAPER 79-SOL-17] 22 p0309 A79-30551

Design guide for shallow solar ponds  
[UCRL-52385] 21 p0185 N79-11497

Optical design of a solar collector for the advanced solar thermal electric conversion/process heat program  
[Y/SUB-77/14261] 21 p0209 N79-13528

Design data brochure for the Owens-Illinois Sunpak (TM) air-cooled solar collector  
[NASA-CR-150868] 21 p0229 N79-15404

Manned remote work station development article  
[NASA-CR-151871] 22 p0330 N79-16057

Parametric study of the performance of a CDIF 1-B coal-fired MHD generator 22 p0361 N79-20503

Multistack nickel-hydrogen units 22 p0371 N79-21610

**STRUCTURAL DESIGN CRITERIA**

Design criteria for multilayer superconductive magnets 22 p0236 A79-20536

Preliminary summary of the ETP conceptual studies  
[NASA-TM-78999] 21 p0183 N79-11478

Design of low-cost structures for photovoltaic arrays. Task 1: Survey of array structural characteristics  
[SAND-78-7021] 21 p0206 N79-13509

Phase one/base data for the development of energy performance standard for new buildings. Task report: Building classification  
[PB-286904/8] 22 p0355 N79-19468

**STRUCTURAL ENGINEERING**

Practical considerations for 'capturing the sun' 21 p0089 A79-15853

Fracture research in Canada 21 p0144 A79-17530

Prefabricated caissons for tidal power development 21 p0152 A79-18113

Austrian 10kWE solar power plant. A project of the Federal Ministry for Science and Research 22 p0349 N79-18460

**STRUCTURAL STRAIN**

Mechanical deflection analysis of diamond turned reflective optics --- for laser fusion 21 p0083 A79-15143

**STRUCTURAL VIBRATION**

On the dynamics of electrostatically precipitated fly ash  
[ASME PAPER 78-WA/FU-3] 21 p0160 A79-19787

On vibration of a thick flexible ring rotating at high speed --- for flywheel energy storage 22 p0235 A79-20511

**STRUCTURAL WEIGHT**

Ultralightweight structures for space power --- solar energy collection for transmission to earth 21 p0108 A79-16609

**SUBMERGED BODIES**

Wave-tank experiments on an immersed parallel-plate duct --- for testing performance of sub-sea wave energy converter 22 p0258 A79-23306

Two-dimensional analyses related to wave-energy extraction by submerged resonant ducts 22 p0312 A79-31099

**SUBSIDENCE**

Remote sensing and mine subsidence in Pennsylvania 22 p0303 A79-29936

**SUBSONIC FLOW**

Subsonic flow in the channel of an MHD-generator 21 p0167 A79-20413

Subsonic diffusers for MHD generators 22 p0279 A79-26185

On supersonic and subsonic diffusers for magnetohydrodynamic generator applications 22 p0279 A79-26186

**SUBSTITUTES**

Some measures of regional-industrial interfuel substitution potentials  
[BNL-24368] 21 p0208 N79-13525

**SUGAR CANE**

Efficiency of sugar cane and cowpea as solar energy converters 21 p0125 A79-17368

**SULFATES**

The oxidation of sulfur dioxide to sulfate aerosols in the plume of a coal-fired power plant 21 p0076 A79-14757

The measurement of the sulfuric acid and sulfate content of particulate matter resulting from the combustion of coal and oil 21 p0156 A79-19219

**SULFIDES**

Electrochemistry of lithium/metal sulfide and calcium/metal sulfide cells using molten salt electrolytes 21 p0040 A79-11832

**SULFUR**

High sulfur fuel effects in a two-cycle high speed army diesel engine  
[AD-A059534] 21 p0216 N79-14232

Behavior of nonmetallic materials in shale oil derived jet fuels and in high aromatic and high sulfur petroleum fuels --- compatibility of aircraft materials to fuels  
[AD-A060322] 21 p0226 N79-15203

Low-sulfur western coal use in existing small and intermediate size boilers --- particulate sampling and combustion efficiency  
[PB-287937/7] 22 p0346 N79-18061

**SULFUR COMPOUNDS**

Engineering and bench-scale studies of the sulfur-iodine cycle at General Atomic 21 p0015 A79-10127

/SH/x-GaAs polymer-semiconductor solar cells 21 p0154 A79-18504

The preparation of some novel electrolytes: Synthesis of partially fluorinated alkane sulfonic acids as potential fuel cell electrolytes  
[AD-A056278] 21 p0184 N79-11483

# SUBJECT INDEX

# SUPERCONDUCTING MAGNETS

## SULFUR DIOXIDES

- Factors limiting limestone utilization efficiency in fluidized-bed combustors --- in determining sulfur dioxide emission level 21 p0008 A79-10069
- Recent operating experience of the Wellman-Lord PGD process on a coal-fired boiler --- flue gas desulfurization 21 p0065 A79-14120
- Limestone SO<sub>2</sub> reactivity and causes for reactivity loss during multi cycle utilization 21 p0065 A79-14121
- The Research-Cottrell/Bahco SO<sub>2</sub> and particulate removal system at Rickenbacker Air Force Base 21 p0065 A79-14122
- The direct reduction of sulfur dioxide 21 p0065 A79-14124
- Simultaneous nitrogen oxides and sulfur dioxide removal by absorption-reduction scrubbing 21 p0066 A79-14125
- The oxidation of sulfur dioxide to sulfate aerosols in the plume of a coal-fired power plant 21 p0076 A79-14757
- The impact of a coal fired power plant on ambient sulfur dioxide levels 21 p0082 A79-15032
- Particulate and sulfur oxide control options for conventional coal combustion 21 p0092 A79-15883
- Commercialization of fluidized-bed combustion systems by the State of Ohio 21 p0096 A79-15923
- Emission control for SO<sub>2</sub> - An update [ASME PAPER 78-JPGC-PWR-11] 21 p0150 A79-18097
- Oxidation of SO<sub>2</sub> on the surface of fly ash particles under low relative humidity conditions 22 p0277 A79-26038

## SULFUR OXIDES

- Particulate and sulfur dioxide emission control costs for large coal-fired boilers [PB-281271/7] 21 p0178 A79-10591

## SULFURIC ACID

- The measurement of the sulfuric acid and sulfate content of particulate matter resulting from the combustion of coal and oil 21 p0156 A79-19219
- Real-time, continuous measurement of automotive sulfuric acid emissions 21 p0156 A79-19359
- Sulfuric acid-water - Chemical heat pump/energy storage system demonstration 22 p0281 A79-26209

## SUNLIGHT

- A new concept for solar pumped lasers 21 p0110 A79-16624
- Response of p-n junction solar cells to concentrated sunlight and partial illumination 21 p0124 A79-17353

## SUPERCONDUCTING MAGNETS

- A superconducting dipole magnet system for the MHD facility at Univ. of Tennessee Space Institute 21 p0017 A79-10140
- Design studies and trade-off analyses for a superconducting magnet/MHD power generator system 21 p0017 A79-10142
- U-25B MHD unit for carrying out investigations under the conditions of strong electric and magnetic fields 21 p0049 A79-12692
- Channel No. 1 of the MHD generator of a U-25B unit for carrying out investigations in strong electric and magnetic fields 21 p0049 A79-12693
- Superconducting magnets - Some fundamentals and their state of the art 21 p0079 A79-14788
- Superconducting magnet systems in EPR designs --- Experimental Power Reactor 21 p0079 A79-14789
- Advances in cryogenic engineering. Volume 23 - Proceedings of the Conference, University of Colorado, Boulder, Colo., August 2-5, 1977 21 p0084 A79-15301
- Commercial realization of MHD - A challenge for superconducting magnets 21 p0084 A79-15302
- Cryogenic aspects of the U.S. SCMS superconducting dipole magnet for MHD research 21 p0084 A79-15303

- Fabrication experiences and operating characteristics of the U.S. SCMS superconducting dipole magnet for MHD research 21 p0084 A79-15304
- Design study of superconducting magnets for a combustion magnetohydrodynamic (MHD) generator 21 p0084 A79-15305
- Design of superconducting magnets for full-scale MHD generators 21 p0084 A79-15306
- Conductor for LASL 10-MW hr superconducting energy storage coil 21 p0085 A79-15309
- High-current power leads for tokamak fusion reactor superconducting magnets 21 p0085 A79-15318
- Superconducting magnets --- for MHD applications 21 p0105 A79-16485
- Design of a D-shaped toroidal field coil 21 p0156 A79-19083
- Electric power losses of current input into superconducting devices cooled by supercritical helium 22 p0235 A79-20530
- Observation of voltage fluctuations in a Superconducting Magnet during MHD power generation 22 p0235 A79-20531
- Design and operating experience of the cryogenic system of the U.S. SCMS as incorporated into the bypass loop of the U-25 MHD generator facility --- Superconducting Magnet System 22 p0235 A79-20532
- A superconducting dipole magnet for the UTSI MHD Facility 22 p0235 A79-20533
- Fabrication and assembly considerations for a base load MHD superconducting magnet system 22 p0235 A79-20534
- Practical aspects of designing and manufacturing MHD superconducting base-load magnets in 1988 time frame 22 p0235 A79-20535
- Design criteria for multilayer superconductive magnets 22 p0236 A79-20536
- Superconducting energy storage magnets 22 p0236 A79-20537
- Heat pulses required to quench a potted superconducting magnet 22 p0236 A79-20538
- The role of the Large Coil Program in the development of superconducting magnets for fusion reactors 22 p0236 A79-20541
- Superconductivity for mirror fusion 22 p0236 A79-20542
- Conceptual design of a superconducting tokamak - 'TORUS II SUPRA' 22 p0236 A79-20543
- 30-MJ superconducting magnetic energy storage /SMES/ unit for stabilizing an electric transmission system 22 p0237 A79-20555
- SLPX - Superconducting Long-Pulse Tokamak Experiment 22 p0237 A79-20557
- A digital control system for superconducting magnet 22 p0268 A79-24508
- Superconducting magnet systems for MHD generator facilities 22 p0290 A79-27662
- High energy physics superconducting magnets and cryogenic systems --- review 22 p0290 A79-27663
- Air Force applications of lightweight superconducting machinery --- in airborne power sources 22 p0290 A79-27666
- Operational characteristics of MHD turbine with air-core superconducting rotor 22 p0297 A79-28924
- ICEC 7; Proceedings of the Seventh International Cryogenic Engineering Conference, London, England, July 4-7, 1978 22 p0311 A79-31001
- Cryogenic technology and superconductivity in controlled fusion 22 p0311 A79-31003

# SUPERCONDUCTIVITY

# SUBJECT INDEX

Superconducting magnets - Present status and problems 22 p0311 A79-31009

Design and development of the US-TESTE toroidal coil 22 p0311 A79-31014

**SUPERCONDUCTIVITY**

Applied Superconductivity Conference, Pittsburgh, Pa., September 25-28, 1978, Proceedings 22 p0235 A79-20526

Superconductivity for mirror fusion 22 p0236 A79-20542

MIT-DOE program to demonstrate an advanced superconducting generator 22 p0236 A79-20549

Applications of cryogenic technology. Volume 7 - Proceedings of the Conference on Cryogenic Energy Systems, Oak Brook, Ill., May 16-18, 1978 22 p0289 A79-27651

Cryogenic technology and superconductivity in controlled fusion 22 p0311 A79-31003

Superconductivity in antenna engineering 22 p0311 A79-31008

Refrigeration requirements for future superconductive energy related applications 22 p0311 A79-31019

**SUPERCONDUCTORS**

Electric power losses of current input into superconducting devices cooled by supercritical helium 22 p0235 A79-20530

Some heat transfer and hydrodynamic problems associated with superconducting cables (SPTL) [NASA-TM-79023] 21 p0226 N79-15267

**SUPERCritical FLOW**

Electric power losses of current input into superconducting devices cooled by supercritical helium 22 p0235 A79-20530

**SUPERHEATING**

Fossil superheating in geothermal steam power plants 21 p0014 A79-10122

Development of small solar power plants for rural areas in India 21 p0141 A79-17502

Structural design of a superheater for a central solar receiver [ASME PAPER 78-WA/PVP-1] 21 p0162 A79-19832

**SUPERPOSITION (MATHEMATICS)**

Application of the superposition principle to solar-cell analysis 22 p0300 A79-29426

**SUPERSONIC DIFFUSERS**

On supersonic and subsonic diffusers for magnetohydrodynamic generator applications 22 p0279 A79-26186

**SUPERSONIC FLOW**

Supersonic flow in an MHD channel with a downwash flow at the inlet 21 p0085 A79-15342

Combustion of hydrogen in a supersonic flow in a channel in the presence of a pseudodiscontinuity 22 p0324 A79-31845

**SUPPLYING**

Energy and input-output analysis --- for predicting impact on U.S. economy 21 p0115 A79-17223

Energy availabilities for state and local development: 1973 data volume [ORNL/TM-5890-S2] 21 p0175 N79-10541

Energy availabilities for state and local development: 1974 data volume [ORNL/TM-5890-S3] 21 p0175 N79-10542

Future aviation fuels fuel suppliers views 21 p0202 N79-13194

US energy demand and supply, 1976-1985: Limited options, unlimited constraints [H-PRINT-95-43] 21 p0228 N79-15400

Symposium on Energy Today and Tomorrow [CSIR-S-145] 22 p0340 N79-17316

The planning and economic aspects of energy supply and demand in South Africa 22 p0341 N79-17325

**SUPPORT SYSTEMS**

Support services for electric vehicles 22 p0301 A79-29492

**SURFACE COOLING**

Drag reduction by cooling in hydrogen fueled aircraft 21 p0165 A79-20084

**SURFACE DIFFUSION**

A study of the effective resistance of the diffused layer and its effect on solar cell performance 22 p0367 N79-21541

**SURFACE DISTORTION**

Optical evaluation techniques for reflecting solar concentrators 21 p0043 A79-11971

**SURFACE EFFECT SHIPS**

Progress towards 100-knot nonconventional ocean ships. II 21 p0155 A79-18519

**SURFACE FINISHING**

Semiconductor liquid junction solar cells - Efficiency, electrochemical stability, and surface preparation 21 p0037 A79-11783

**SURFACE GEOMETRY**

Effect of surface curvature on measurement of the absorptance properties of solar coatings 21 p0042 A79-11879

Optimum collection geometries for copper tube - copper sheet flat plate collectors 21 p0127 A79-17387

Performance of optimal geometry three step compound wedge stationary concentrator --- solar collector using flat side mirrors 21 p0134 A79-17438

Geometrical aspects of a cylindrical parabolic collector 21 p0134 A79-17443

Cavity-type surfaces for solar collectors 22 p0283 A79-26497

**SURFACE LAYERS**

Status report on selective surfaces --- solar collector absorbers 21 p0126 A79-17374

A study of the effective resistance of the diffused layer and its effect on solar cell performance 22 p0367 N79-21541

**SURFACE PROPERTIES**

The structure and properties of Cu based selective surfaces formed on an Al-Cu alloy by chemical brightening and etching treatments --- for flat plate solar collectors 21 p0127 A79-17384

Radiation regime of inclined surfaces --- Russian book on solar energy engineering and microclimatology 22 p0282 A79-26353

Effect of form errors on the characteristics of ellipsoidal radiant energy concentrators 22 p0296 A79-28667

Development of surfaces optically suitable for flat solar panels [NASA-CR-150831] 21 p0173 N79-10522

**SURFACE REACTIONS**

Study of the interaction of H2O and O2 with the surface of TiO2 by electron stimulated desorption and Auger and characteristic loss spectroscopies 21 p0037 A79-11793

Charge transfer by surface states in the photoelectrolysis of water using a semiconductor electrode 22 p0254 A79-22320

**SURFACE TEMPERATURE**

Computation of IR sky temperature and comparison with surface temperature --- for solar collector energy budgets 21 p0042 A79-11875

Effect of the properties of the working body on the selection of the temperature of the surface of the electrodes of the channel of an MHD generator 21 p0167 A79-20419

**SURFACE VEHICLES**

Bus priority system studies 22 p0299 A79-29339

The fleet operator's viewpoint --- on prototype electric bus development 22 p0302 A79-29495

## SUBJECT INDEX

## SYNTHETIC FUELS

- A study of flywheel energy storage for urban transit vehicles  
[PB-282929/9] 21 p0177 N79-10563
- SURFACTANTS**  
Surfactant-assisted liquefaction of particulate carbonaceous substances  
[NASA-CASE-WFO-13904-1] 21 p0179 N79-11152
- SURVEYS**  
A time domain survey of the Los Alamos Region, New Mexico  
[LA-7657-MS] 22 p0365 N79-21248
- SUSPENDING (MIXING)**  
Solids mixing and fluidization characteristics in a tube filled bed --- of fluidized bed coal combustion 21 p0008 A79-10070
- SWATH (SHIP)**  
Progress towards 100-knot nonconventional ocean ships. II 21 p0155 A79-18519
- SWEDEN**  
Large-scale introduction of wind power stations in the Swedish grid A simulation study 22 p0300 A79-29373
- SWIRLING**  
The MHD interaction and plasma properties in a shock tube driven disk generator with swirl 21 p0083 A79-15260
- SWITCHING CIRCUITS**  
Electronic components in solar technology 21 p0056 A79-13629
- SYNCHRONOUS MOTORS**  
Laboratory evaluation of a composite flywheel energy storage system 21 p0013 A79-10110
- SYNCHRONOUS SATELLITES**  
Nickel-cadmium battery reconditioning and long term performance in geosynchronous orbit spacecraft 21 p0029 A79-10242  
Enhanced power generation by optical solar reflectors on geostationary spinners 22 p0272 A79-25138  
Synchronous meteorological and geostationary operational environmental satellites battery and power system design 22 p0370 N79-21571
- SYNCHROTRON RADIATION**  
Application of electron beams in space for energy storage and optical beam generation 21 p0108 A79-16606
- SYNOPTIC METEOROLOGY**  
On the use of synoptic weather map typing to define solar radiation regimes 22 p0272 A79-25392
- SYNTHANE**  
Synthane - A process for the gasification of caking and noncaking coals 21 p0006 A79-10057  
Novel technology for conversion of methanol and synthesis gas to hydrocarbons 21 p0007 A79-10064  
SNG production by the Rockgas process 21 p0093 A79-15896  
Substitute natural gas from coal using high-temperature reactor heat - Project 'Prototype Plant Nuclear Process Heat' 22 p0264 A79-23827  
Gasification of coal with high-temperature reactor heat - Investigations concerning the market and the economics 22 p0264 A79-23828  
Methane formation during the hydrogasification and the gas phase pyrolysis of defined aromatics 22 p0265 A79-23829  
Gasification of raw lignite in the tube-furnace gasifier 22 p0310 A79-30996  
Chemicals from coal. Report based on HRI H-coal product [FE-1534-50] 21 p0180 N79-11166
- SYNTHESIS**  
Synthesis and properties of useful metal hydrides - A review of recent work at Brookhaven National Laboratory 22 p0250 A79-21699
- SYNTHETIC FUELS**  
The status of alcohol fuels utilization technology for highway transportation 21 p0003 A79-10035  
Hydrogen production from high temperature electrolysis and fusion reactor 21 p0015 A79-10126  
Some problems and benefits from the hydrogen fueled spark ignition engine 21 p0016 A79-10130  
Utility fuel cells for biomass fuel 21 p0016 A79-10131  
Characteristics and combustion of future hydrocarbon fuels 21 p0036 A79-11599  
Catalysis in coal conversion --- Book 21 p0051 A79-12873  
Alternative hydrocarbon fuels: Combustion and chemical kinetics; SQUID Workshop, Loyola College, Columbia, Md., September 7-9, 1977, Technical Papers 21 p0051 A79-12977  
Alternative fuels and combustion problems 21 p0051 A79-12978  
Future fuels in gas turbine engines 21 p0051 A79-12979  
Alternative fuels for reciprocating internal combustion engines 21 p0051 A79-12980  
Use of alternative fuels in stationary combustors 21 p0052 A79-12981  
Ignition/stabilization/atomization - Alternative fuels in gas turbine combustors 21 p0052 A79-12982  
Combustion of droplets and sprays of some alternative fuels 21 p0052 A79-12983  
Flame emissivities - Alternative fuels 21 p0052 A79-12984  
Role of aromatics in soot formation 21 p0053 A79-12988  
Emission control techniques for alternative fuel combustion 21 p0053 A79-12990  
Vehicle operation on fuels from solar energy 21 p0059 A79-13663  
Alternate aircraft fuels prospects and operational implications 21 p0066 A79-14138  
The fate of fuel nitrogen - Implications for combustor design and operation 21 p0080 A79-14927  
Biomass and wastes as energy resources - 1977 update 21 p0091 A79-15868  
Integrated low Btu gasification, combined cycle plant considerations and control 21 p0094 A79-15905  
Synthetic fuels from coal 21 p0145 A79-17636  
Synthetic fuels from Gulf Coast lignite 21 p0146 A79-17643  
The Dow Chemical liquefaction process 21 p0147 A79-17644  
A characteristic time correlation for combustion inefficiency from alternative fuels [AIAA PAPER 79-0357] 21 p0158 A79-19687  
Synthetic oil from coal - The economic impact of five alternatives for making hydrogen from coal and steam 22 p0262 A79-23719  
An economic analysis of synthetic fuels production from eastern oil shale via hydrotretort processing 22 p0264 A79-23780  
Effects of fuel properties on soot formation in turbine combustion [SAE PAPER 781026] 22 p0274 A79-25899  
Shale oil - The answer to the jet fuel availability question [SAE PAPER 781027] 22 p0274 A79-25900  
Evaluation of the application of some gas chromatographic methods for the determination of properties of synthetic fuels 22 p0274 A79-25917  
Fuels of the future. I --- demand and proposed sources 22 p0282 A79-26404

## SYSTEM EFFECTIVENESS

Sampling and analysis of synthetic fuel processes  
 --- coal gasification and liquefaction effluent analysis 22 p0284 A79-26538

Solid waste and biomass. Their potential as energy sources in Illinois, 1977 [PB-281649/4] 21 p0177 A79-10562

The preparation of some novel electrolytes: Synthesis of partially fluorinated alkane sulfonic acids as potential fuel cell electrolytes [AD-A056278] 21 p0184 A79-11483

Further studies of fuels from alternate sources: Fire extinguishment experiments with JF-5 jet turbine fuel derived from shale [AD-A058586] 21 p0201 A79-13182

Identification of probable automotive fuels composition: 1985-2000 [HCP/W3684-01/1] 21 p0201 A79-13191

Naval Air Systems Command-Naval Research Laboratory Workshop on Basic Research Needs for Synthetic Hydrocarbon Jet Aircraft Fuels [AD-A060081] 21 p0216 A79-14235

Current and projected fuel costs --- electric rate schedules and projected costs of fossil, synthetic, and nuclear fuels 21 p0218 A79-14532

Engineering and economic analysis of waste to energy systems [PB-285797/7] 21 p0224 A79-14946

Evaluation of the application of some gas chromatographic methods for the determination of properties of synthetic fuels [NASA-TM-79035] 22 p0338 A79-16930

Alternative hydrocarbon fuels: Combustion and chemical kinetics --- synthetic aircraft fuels [AD-A061050] 22 p0338 A79-17011

Pollutants from synthetic fuels production: Facility construction and preliminary tests --- coal gasification plant effluents [PB-287730/6] 22 p0339 A79-17027

Public hearing transcript: Federal non-nuclear energy research and development program [PB-287910/4] 22 p0349 A79-18464

Synthetic fuels: Methane. Citations from the Engineering Index data base [NTIS/PS-79/0030/1] 22 p0365 A79-21223

Preliminary environmental assessment of biomass conversion to synthetic fuels [PB-289775/9] 22 p0365 A79-21224

**SYSTEM EFFECTIVENESS**

A critical review and evaluation of published electric-vehicle performance data 21 p0009 A79-10081

Life cycle costing of energy systems 21 p0072 A79-14683

A methodology for evaluating the effectiveness of energy conservation programs 21 p0072 A79-14684

Considerations in choosing solar energy monitoring systems 21 p0087 A79-15831

Experience gained and lessons learned from monitoring the solar building, Albuquerque 21 p0088 A79-15833

The use of computer-controlled data acquisition systems in determining solar heating and cooling system performance 21 p0088 A79-15834

System performance measurements for a packaged solar space heating system equipped with air-heating collectors 21 p0088 A79-15835

Temperature calibration for solar heating and cooling system evaluation 21 p0089 A79-15846

Incentives and requirements for gasification based power systems 21 p0094 A79-15904

Thermal storage of solar energy 21 p0103 A79-16459

Non-adaptive optics for solar thermal electric power 21 p0112 A79-16733

A study for optimum use of metallic plates for thermal storage in solar processes 21 p0122 A79-17331

Economic evaluation of the ATC/Wellman incandescent two-stage low Btu coal gas producer 21 p0146 A79-17640

## SUBJECT INDEX

Calculation of flat-plate collector utilizability 21 p0149 A79-18020

Gas-cycle solar refrigeration system performance 21 p0153 A79-18471

Energy storage efficiency for the ammonia/hydrogen-nitrogen thermochemical energy transfer system 22 p0261 A79-23718

Solar heating, cooling and hot water production - A critical look at CCHS installations 22 p0275 A79-25931

Solar air heating and nocturnal cooling system /CSU Solar House II/ 22 p0275 A79-25932

The Philips experimental house - A system's performance study --- of solar energy utilization and energy conservation 22 p0277 A79-25941

Evaluation of the effectiveness of electric power systems for transport purposes 22 p0284 A79-26723

Studies on solar collector performance at NRC 22 p0322 A79-31451

First year performance data and lessons learned in the NRC 14 house solar demonstration program 22 p0323 A79-31453

A hybrid wind turbine suitable for developing regions 22 p0323 A79-31455

Solar assisted heat pump study for heating of military facilities [AD-A058626] 21 p0206 A79-13506

Results of systems analysis --- effectiveness of integrated solar energy systems 21 p0218 A79-14534

Parameter estimation and validation of a solar assisted heat pump model 22 p0332 A79-16349

**SYSTEM FAILURES**

Is there repair after failure --- reliability of repairable vs. nonrepairable engines 21 p0086 A79-15378

Failure analysis in coal conversion systems --- pilot plant for liquefaction 22 p0266 A79-24137

**SYSTEMS**

Satellite Power Systems (SPS) concept definition study. Volume 7: SPS program plan and economic analysis [NASA-CR-158068] 21 p0225 A79-15141

**SYSTEMS ANALYSIS**

A thermodynamic study of heating with geothermal energy [ASME PAPER 77-WA/ENER-1] 21 p0030 A79-10253

A commentary on a methodology for assessment of the environmental impact of the electrical power system within the Connecticut River Basin 21 p0093 A79-15893

Potential research problems in energy systems analysis 21 p0115 A79-17221

A solar energy system with a dual-source heat pump and long-term storage 21 p0119 A79-17312

The analysis by stochastic modelling of solar systems for space and water heating 21 p0137 A79-17466

Parametric analysis of power conversion systems for central receiver solar power generation [ASME PAPER 78-WA/SOL-2] 21 p0162 A79-19835

NRC solar monitoring program 22 p0318 A79-31419

Satellite power systems program 21 p0169 A79-10128

Study of flywheel energy storage. Volume 2: Systems analysis [PB-282653/5] 21 p0176 A79-10556

Public policy 21 p0179 A79-11011

Fuel cell on-site integrated energy system parametric analysis of a residential complex [NASA-TM-78996] 21 p0193 A79-11955

Initial assessment: Electromagnetic compatibility aspects of proposed SPS Microwave Power Transmission System (MPTS) operations [PNL-2482] 21 p0202 A79-13252

Parametric requirements for noncircular Tokamak commercial fusion plants [GA-A-14876] 21 p0214 A79-13871



# SUBJECT INDEX

# SYSTEMS ENGINEERING

Parametric requirements for noncircular Tokamak commercial fusion plants  
[GA-A-14946] 21 p0214 N79-13872

Application of solar technology to today's energy needs, volume 2 --- systems analysis and analytical methods  
[OTA-E-77-VOL-2] 21 p0218 N79-14530

Analytical methods 21 p0218 N79-14531

Calculation of backup requirements 21 p0218 N79-14533

Results of systems analysis --- effectiveness of integrated solar energy systems 21 p0218 N79-14534

Satellite Power Systems (SPS) concept definition study. Volume 3: SPS concept evolution  
[NASA-CR-158066] 21 p0225 N79-15138

The 25 kw power module updated baseline system --- for space transportation system payloads  
[NASA-TN-78212] 21 p0226 N79-15247

Satellite Power Systems (SPS) concept definition study. Volume 2: SPS system requirements  
[NASA-CR-150681] 22 p0330 N79-16037

Qualification test and analysis report: Solar collectors  
[NASA-CR-150860] 22 p0333 N79-16360

Preliminary design package for Sunair SPC-601 solar collector  
[NASA-CR-150875] 22 p0341 N79-17332

System integration of marketable subsystems --- for residential solar heating and cooling  
[NASA-CR-161104] 22 p0348 N79-18448

Satellite Power System (SPS) concept definition study (exhibit C)  
[NASA-CR-161173] 22 p0352 N79-19071

Technical support for open-cycle MHD program  
[ANL-MHD-78-8] 22 p0361 N79-20507

Measurement and control techniques in geothermal power plants  
[TREE-1312] 22 p0362 N79-20508

**SYSTEMS COMPATIBILITY**  
Compatibility of direct energy storage devices with ac. processing power system components 21 p0111 A79-16728

**SYSTEMS ENGINEERING**  
A microwave power transmission system for space satellite power 21 p0002 A79-10025

A 5-GWe nuclear satellite power system conceptual design 21 p0003 A79-10033

Conceptual design and cost estimate 600 MWe coal fired fluidized-bed combined cycle power plant 21 p0008 A79-10068

Pressurized fluidized-bed combustion/component test and integration unit preliminary design report 21 p0008 A79-10076

Heat exchanger designs for coal-fired fluidized beds 21 p0009 A79-10079

Design studies and trade-off analyses for a superconducting magnet/MHD power generator system 21 p0017 A79-10142

Fusion-Fission Energy Systems 21 p0017 A79-10144

Analysis and design of an 18-ton solar-powered heating and cooling system 21 p0019 A79-10156

Conceptual design of the Fort Hood Solar Total Energy-Large Scale Experiment 21 p0019 A79-10160

Hybrid air to water solar collector design 21 p0021 A79-10174

Design and operating experience on the U.S. Department of Energy Experimental Mod-O 100 kW Wind Turbine 21 p0028 A79-10234

Powerplant integration - The application of current experience to future developments  
[ASME PAPER 78-GT-113] 21 p0032 A79-10788

Solar thermal electric power systems - Manufacturing cost estimation and systems optimization 21 p0046 A79-12273

The efficiencies of thermochemical energy transfer 21 p0054 A79-13575

Solar heating and safety techniques 21 p0056 A79-13633

Total energy systems --- domestic solar and windpowered facilities 21 p0058 A79-13654

Fusion reactor problems --- plasma confinement and interface engineering 21 p0071 A79-14468

Residential energy design 21 p0073 A79-14694

Heat pumps without supplemental heat 21 p0073 A79-14695

Modelling energy storage systems for electric utility applications Preliminary considerations 21 p0081 A79-14960

Risk control in the development of energy processes --- environment, worker and capital considerations in coal gasification 21 p0085 A79-15372

Solar absorption cooling 21 p0090 A79-15861

Theory of solar assisted heat pumps 21 p0090 A79-15864

SHG production by the Rockgas process 21 p0093 A79-15896

Status of photovoltaic systems and applications 21 p0095 A79-15907

Ocean energy unlimited --- water wave conversion 21 p0095 A79-15908

OTEC power systems 21 p0101 A79-16248

Advances in ocean engineering aspects of ocean thermal energy conversion 21 p0101 A79-16250

Solar collectors. I - Fundamentals and collectors of the past and present 21 p0103 A79-16455

Integrated solar building systems 21 p0103 A79-16460

Energy storage requirements for autonomous and hybrid solar thermal electric power plants 21 p0120 A79-17315

A cost effective total energy system using a faceted mirror sunlight concentrator and high intensity solar cells 21 p0135 A79-17446

The interface with solar - Alternative auxiliary supply systems --- for solar space heating 21 p0137 A79-17468

Optimizing solar energy systems using continuous flow control 21 p0138 A79-17477

A solar heating and cooling system for an industrial plant located in southern Europe 21 p0139 A79-17480

An earth-wrapped solar greenhouse house --- partially buried structure 21 p0140 A79-17493

Wind generation of electricity for a novel dwelling independent of servicing networks 21 p0142 A79-17513

The use of wave powered systems for desalination - A new opportunity --- seawater pumping for reverse osmosis 21 p0151 A79-18108

Principles of design and construction for marine structures for wave/tidal/ocean thermal energy 21 p0152 A79-18114

Conceptual design of large heat exchangers for ocean thermal energy conversion  
[ASME PAPER 78-WA/HT-32] 21 p0161 A79-19813

Design and operating experience of the cryogenic system of the U.S. SCMS as incorporated into the bypass loop of the U-25 MHD generator facility --- Superconducting Magnet System 22 p0235 A79-20532

Analysis and design of a field of heliostats for a solar power plant 22 p0242 A79-21161

Experimental investigations of a physical system capable of using solar energy 22 p0247 A79-21667

Encapsulant materials for \$2/watt terrestrial photovoltaic arrays 22 p0266 A79-24138

Design considerations for residential solar heating and cooling systems utilizing evacuated tube solar collectors 22 p0285 A79-26815

Principles of solar engineering --- Book 22 p0287 A79-27372

Technology Considerations in the design of a commercial offshore energy conversion /OTEC/ plant  
22 p0288 A79-27378

System designs for low cost-low ratio solar concentrators  
22 p0293 A79-28142

A general design method for closed-loop solar energy systems  
22 p0295 A79-28359

Optimum power plant capacity of ocean-based ocean thermal energy conversion systems  
22 p0297 A79-28922

Conceptual design of a solar powered closed-cycle gas turbine electric power generation system  
[ASME PAPER 79-GT-43] 22 p0306 A79-30522

Design considerations of small solar collector systems using plane heliostats.  
[ASME PAPER 79-SOL-2] 22 p0307 A79-30540

Unique aspects of terrestrial photovoltaic system design  
[ASME PAPER 79-SOL-14] 22 p0308 A79-30548

Integration of a passive and active solar heated, low density, multiple dwelling with atrium  
22 p0322 A79-31446

Cylindrical parabolic collector optimization for interfacing with steam turbine generators  
22 p0322 A79-31448

Development of the combustion chamber of an experimental MHD generator  
22 p0327 A79-32105

Four ignition TNS Tokamak reactor systems: Design summary  
[ORNL/SUB-7117/25] 21 p0193 A79-11889

Alternative energy sources for Federal Aviation Administration facilities  
[AD-A058681] 21 p0196 A79-12555

Conceptual design of thermal energy storage systems for near term electric utility applications. Volume 1: Screening of concepts  
[NASA-CR-159411-VOL-1] 21 p0205 A79-13496

Concentrator enhanced solar arrays design study  
[NASA-CR-158032] 21 p0219 A79-14546

Satellite Power System (SPS) concept definition study (exhibit C)  
[NASA-CR-150733] 21 p0225 A79-15137

The economics and engineering of large-scale algae biomass energy systems  
[PB-287868/4] 21 p0226 A79-15207

Development of a high energy storage flywheel module  
[AD-A060351] 21 p0230 A79-15413

Coal research: Data systems and information transfer  
[ORAU-133] 21 p0232 A79-15830

Satellite power systems (SPS) concept definition study. Volume 1: Executive summary  
[NASA-CR-150700] 22 p0329 A79-16036

System design package for SIMS prototype system 3, solar heating and domestic hot water  
[NASA-CR-150840] 22 p0333 A79-16359

Qualification test and analysis report: Solar collectors  
[NASA-CR-150860] 22 p0333 A79-16360

System design package for SIMS prototype system 4, solar heating and domestic hot water  
[NASA-CR-150839] 22 p0333 A79-16361

Environmental assessment data base for coal liquefaction technology. Volume 1: Systems for 14 liquefaction processes  
[PB-287799/1] 22 p0344 A79-17364

Environmental assessment data base for coal liquefaction technology. Volume 2: Synthoil, H-coal, and Exxon donor solvent processes  
[PB-287800/7] 22 p0344 A79-17365

The 25 kW power module evolution study. Part 3: Conceptual designs for power module evolution. Volume 2: Program plans  
[NASA-CR-161146] 22 p0345 A79-17890

Expert opinion on wind energy conversion systems designed by Hermann Honnef  
[BMFT-PB-1-77-35] 22 p0349 A79-18456

Satellite Power System (SPS) concept definition study (exhibit C)  
[NASA-CR-161173] 22 p0352 A79-19071

MHD-ETF program. Volume 1: Executive summary  
[FE-2613-6-VOL-1] 22 p0362 A79-20515

MHD-ETF program. Volume 2A, parts 1 and 2: Reference design description  
[FE-2613-6-VOL-2A] 22 p0363 A79-20516

Active heat exchange system development for latent heat thermal energy storage  
[NASA-CR-159479] 22 p0368 A79-21554

Development, testing and evaluation of MHD materials and component designs --- electrode and insulator systems for mhd generators  
[FE-2248-19] 22 p0369 A79-21558

Engineering test facility conceptual design, part 1  
[FE-2614-2-PT-1] 22 p0369 A79-21560

Engineering test facility conceptual design, part 2  
[FE-2614-2-PT-2] 22 p0369 A79-21561

Synchronous meteorological and geostationary operational environmental satellites battery and power system design  
22 p0370 A79-21571

## SYSTEMS MANAGEMENT

OAST space power technology program  
21 p0169 A79-10123

Historical and projected power requirements  
21 p0169 A79-10125

Power management and control for space systems  
21 p0170 A79-10134

## T

## T-63 ENGINE

Testing to assess the affect of degraded fuel specifications on the cold start ability of a T63-A-700 engine  
[AIAA 79-7009] 22 p0300 A79-29384

## TABLES (DATA)

End use energy consumption data base: Series 1 tables  
[PB-281817/7] 21 p0177 A79-10560

## TAILLESS AIRCRAFT

Very large vehicles - To be or --- aircraft design concepts  
22 p0306 A79-30484

Large-vehicle concepts --- aircraft design  
22 p0306 A79-30485

## TANKER AIRCRAFT

Winglets give USAF KC-135 new look in life  
22 p0265 A79-23975

## TAR SANDS

Oil recovery from a Utah tar sand deposit by in situ combustion  
21 p0004 A79-10043

## TAYLOR INSTABILITY

MHD instabilities  
22 p0259 A79-23599

## TDR SATELLITES

Design features of the TDRSS solar array --- Tracking and Data Relay Satellites  
21 p0002 A79-10019

## TECHNOLOGICAL FORECASTING

Energy conversion in the long run  
21 p0019 A79-10154

Prospects of thermionic power systems  
21 p0026 A79-10220

Advanced turbofan engines for low fuel consumption  
[ASME PAPER 78-GT-192] 21 p0033 A79-10816

Evolution of space power systems  
[IAF PAPER 78-43] 21 p0035 A79-11218

Wind, waves, and tides --- as future energy sources  
21 p0074 A79-14719

Electric vehicles challenge battery technology  
21 p0093 A79-15892

Large-scale human benefits from the industrialization of space  
21 p0099 A79-16136

Prospects for ambient energy and cogeneration utilization in urban and regional planning  
21 p0104 A79-16465

The impact of advanced technology on the future electric energy supply problem  
21 p0112 A79-16736

Input-output method applied to energy planning  
21 p0112 A79-16737

Space Shuttle - America's wings to the future --- Book  
21 p0114 A79-17124

A low energy scenario for the United States - 1975-2050  
21 p0147 A79-17649

Progress towards 100-knot nonconventional ocean ships. II  
21 p0155 A79-18519

# SUBJECT INDEX

# TECHNOLOGY ASSESSMENT

- Practical aspects of designing and manufacturing  
MHD superconducting base-load magnets in 1988  
time frame 22 p0235 A79-20535
- The prospects of hydrogen as an energy carrier for  
the future 22 p0247 A79-21677
- Energy for the long run - Fission or fusion 22 p0256 A79-22760
- Electric vehicle progress in the U.S. - Where to 22 p0269 A79-24611
- Wind energy - The long road to commercialization 22 p0269 A79-24612
- Energy development --- for future global demand 22 p0282 A79-26402
- Fuels of the future. I --- demand and proposed  
sources 22 p0282 A79-26404
- Prospects for improvements in lead-acid batteries  
--- for electric vehicles 22 p0300 A79-29488
- Electric vehicles - Can they be fitted into urban  
Britain 22 p0301 A79-29493
- The impact of alternate energy resources on the  
future supply of electric power  
[IEEE PAPER 78-672-8] 22 p0304 A79-29939
- Do photovoltaics have a future  
[ASME PAPER 79-SOL-7] 22 p0308 A79-30543
- Uncoupling of economic growth and energy  
consumption - A new strategy of energy politics  
or only a new slogan 22 p0310 A79-30997
- The Solar Power Satellite concept - Towards the  
future 22 p0327 A79-31925
- Future large space systems opportunities: A case  
for space-to-space power? --- spacecraft power  
supplies microwave and laser transmission  
21 p0169 A79-10095
- Technology assessment, volume 2. A bibliography  
with abstracts  
[NTIS/PS-78/0830/6] 21 p0179 A79-10951
- Identification of probable automotive fuels  
consumption: 1985-2000, executive summary  
[HCF/W3684-01/2] 21 p0194 A79-12249
- Identification of probable automotive fuels  
composition: 1985-2000  
[HCF/W3684-01/1] 21 p0201 A79-13191
- The good news about energy 22 p0355 A79-19461
- TECHNOLOGY ASSESSMENT**
- The status of alcohol fuels utilization technology  
for highway transportation 21 p0003 A79-10035
- Coal liquefaction - Status and new directions 21 p0007 A79-10062
- Alternatives for coal based power generation - An  
international overview 21 p0008 A79-10074
- Analysis and application of the heat pipe heat  
exchanger 21 p0014 A79-10117
- Progress report on hydrogen production and  
utilization for community and automotive power 21 p0016 A79-10132
- A summary of USSR thermionic energy conversion  
activity 21 p0026 A79-10216
- Selenide thermoelectric converter technology 21 p0026 A79-10221
- Militarized thermoelectric power sources 21 p0027 A79-10227
- The laser fusion scientific feasibility experiment 21 p0030 A79-10250
- Solar power satellite developments  
[AAS PAPER 78-022] 21 p0035 A79-11558
- Energy conservation aircraft design and  
operational procedures  
[ONERA, TP NO. 1978-107] 21 p0036 A79-11572
- Fuel cell electrocatalysis - Where have we failed 21 p0039 A79-11810
- ERDA fuel cell programs 21 p0039 A79-11814
- The state-of-the-art of hydrogen-air phosphoric  
acid electrolyte fuel cells 21 p0039 A79-11815
- Molten carbonate fuel cell systems - Status and  
potential 21 p0039 A79-11817
- Options for solar thermal conversion 21 p0043 A79-11969
- Technology and development requirements of the  
solar power satellite 21 p0046 A79-12267
- Progress and trends in the development of  
terrestrial photoelectric conversion 21 p0056 A79-13635
- Potential and technical utilization of renewable  
energy sources 21 p0058 A79-13655
- Space power technology - Current status and future  
development trends --- for powering spacecraft  
[DGLR PAPER 78-167] 21 p0063 A79-14054
- State-of-the-art assessment of air pollution  
control technologies for various waste-as-fuel  
processes 21 p0064 A79-14111
- Electricity from sunlight --- low cost silicon for  
solar cells 21 p0065 A79-14116
- Technology for aircraft energy efficiency 21 p0066 A79-14136
- Summary of international energy research and  
development activities 1974-1976 --- Book 21 p0068 A79-14400
- Current state-of-the-art of electrochemical  
batteries from a users point of view 21 p0071 A79-14681
- Recovery of oil from oil shale - An overall  
technological perspective 21 p0073 A79-14698
- Annual review of energy. Volume 3 --- Book 21 p0074 A79-14718
- Superconducting magnets - Some fundamentals and  
their state of the art 21 p0079 A79-14788
- History of solar energy applications - Solar  
energy yesterday, today and tomorrow 21 p0089 A79-15852
- Utility applications of wind power plants 21 p0092 A79-15882
- Materials and economics of energy systems 21 p0095 A79-15911
- Perspective on the fusion-fission energy concept 21 p0095 A79-15913
- Energy/environment technology areas to be developed 21 p0097 A79-16077
- Solar collectors. I - Fundamentals and collectors  
of the past and present 21 p0103 A79-16455
- Solar collectors. II - Recent developments and  
future performance data and economic analysis 21 p0103 A79-16456
- The solar power satellite concept evaluation program 21 p0107 A79-16602
- Progress in nuclear-pumped lasers 21 p0110 A79-16627
- Historical review of adaptive optics technology 21 p0114 A79-17171
- A pilot line for the production of large area  
Cu/x/S-CdS solar cells 21 p0124 A79-17351
- Assessment of current flue gas desulfurization  
technology 21 p0145 A79-17637
- MHD power generation 21 p0146 A79-17638
- Beneficiation of lignites 21 p0146 A79-17642
- Current status of composite flywheel development 22 p0241 A79-20853
- Oil shale in the U.S. - Current state of  
technology and research 22 p0265 A79-23830
- Status report on TFTR --- Toroidal Fusion Test  
Reactor 22 p0290 A79-27669
- Electric car project of the Eindhoven University  
of Technology 22 p0302 A79-29498
- An overview of photovoltaic power systems  
[ASME PAPER 79-SOL-12] 22 p0308 A79-30547
- Low cost thin-film CdS-based solar cells progress  
and promise  
[ASME PAPER 79-SOL-15] 22 p0309 A79-30549

The Stirling engine for automotive application  
[SAE PAPER 790329] 22 p0315 A79-31370

Status of the SPS concept development and  
evaluation program --- Solar Power Satellite  
22 p0326 A79-31919

Photovoltaics and solar thermal conversion to  
electricity - Status and prospects  
22 p0326 A79-31924

Solar energy in developing countries: An overview  
and buyers' guide for solar scientists and  
engineers --- Book  
22 p0327 A79-32139

Future Orbital Power Systems Technology Requirements  
[NASA-CP-2058] 21 p0169 N79-10122

Military needs for orbital power  
21 p0169 N79-10127

Solar array systems  
21 p0169 N79-10131

Technology status: Batteries and  
fuel cells  
21 p0170 N79-10132

Technology status: Fuel cells and electrolysis  
cells  
21 p0170 N79-10133

Solar cell workshop  
21 p0170 N79-10141

Solar array workshop  
21 p0170 N79-10142

Battery workshop  
21 p0170 N79-10143

Net energy analysis of five energy systems  
[ORAU/PA(R)-77-12] 21 p0174 N79-10534

Solar powered irrigation: Present status and  
future outlook  
[SAND-78-C016C] 21 p0175 N79-10539

Status of the DOE photovoltaic concentrator  
technology development project  
[SAND-78-C948C] 21 p0176 N79-10550

Environmental control technology activities of the  
Department of Energy in FY 1977  
[DOE/EV-0030] 21 p0178 N79-10572

Technology assessment, volume 2. A bibliography  
with abstracts  
[NTIS/PS-78/0830/6] 21 p0179 N79-10951

Need for and deployment of inexhaustible energy  
resource technologies: Report of Technology  
Study Panel inexhaustible energy resources study  
[TID-28202] 21 p0186 N79-11510

National Geothermal Information Resource  
[LBL-7803] 21 p0187 N79-11515

Integrating technologies to produce energy  
conservation  
[CONP-780109-6] 21 p0189 N79-11541

Application of solar technology to today's energy  
needs, volume 1  
[PB-283774/6] 21 p0190 N79-11548

Pulsed-power research and development in the USSR  
[AD-A056635] 21 p0193 N79-11859

Assessment of SEPS solar array technology for  
orbital service module application  
[NASA-CR-151859] 21 p0194 N79-12136

Methanol from wood waste: A technical and  
economic study  
[PPL-12] 21 p0194 N79-12239

Alternative energy sources for Federal Aviation  
Administration facilities  
[AD-A058681] 21 p0196 N79-12555

Technical and environmental aspects of oil shale  
processing  
21 p0199 N79-12581

Program information notice --- technologies  
relevant to u.s. electric energy systems  
[DOE/ET-0059] 21 p0207 N79-13517

Energy systems studies program  
[BNL-50822] 21 p0209 N79-13526

Heat pump technology: A survey of technical  
developments, market prospects and research needs  
[HCP/M2121-01] 21 p0210 N79-13540

Stored energy calculation: The state of the art  
[PNL-2581] 21 p0210 N79-13541

Solar energy, water, and industrial systems in  
arid lands: Technological overview and  
annotated bibliography  
[PB-285129/3] 21 p0211 N79-13549

Environmental control implications of generating  
electric power from coal. Appendix A, part 2:  
Coal preparation and cleaning assessment study  
appendix  
[ANL/ECT-3-APP-A-PT-2] 21 p0213 N79-13571

Present status of GaAs --- including space  
processing and solid state applications  
[NASA-CR-3093] 21 p0215 N79-14192

Technology and Use of Lignite --- conferences  
[GPERC/IC-77/1] 21 p0216 N79-14241

OAST Space Theme Workshop. Volume 1: Summary  
report. 1: Introduction. 2: General  
observations and some key findings. 3:  
Follow-on activity. Quick-look comments and  
working papers  
[NASA-TM-80001] 21 p0224 N79-15113

OAST Space Theme Workshop. Volume 2: Theme  
summary. 1: Space power (no. 7). A. Theme  
statement. B. 26 April 1976 presentation. C.  
Summary. D. Initiative action  
[NASA-TM-80002] 21 p0225 N79-15114

OAST Space Theme Workshop. Volume 3: Working  
group summary. 6: Power (P-2). A. Statement.  
B. Technology needs (form 1). C. Priority  
assessment (form 2)  
[NASA-TM-80013] 21 p0225 N79-15125

Satellite Power Systems (SPS) concept definition  
study. Volume 6: SPS technology requirements  
and verification  
[NASA-CR-150685] 21 p0225 N79-15140

The economics and engineering of large-scale algae  
biomass energy systems  
[PB-287868/4] 21 p0226 N79-15207

Assessment of coal cleaning technology  
[PB-287091/3] 22 p0330 N79-16139

Industrialization study, phase 2 --- assessment of  
advanced photovoltaic technologies for  
commercial development  
[NASA-CR-158015] 22 p0333 N79-16351

Hydrogen technology from thermonuclear research  
22 p0338 N79-16997

New initiatives in high altitude aircraft  
22 p0338 N79-17000

Environmental assessment data base for coal  
liquefaction technology. Volume 1: Systems for  
14 liquefaction processes  
[PB-287799/1] 22 p0344 N79-17364

Environmental assessment data base for coal  
liquefaction technology. Volume 2: Synthoil,  
B-coal, and Exxon donor solvent processes  
[PB-287800/7] 22 p0344 N79-17365

Technology assessment of western energy resource  
development  
22 p0347 N79-18368

Austrian 10kWE solar power plant. A project of  
the Federal Ministry for Science and Research  
22 p0349 N79-18460

MHD power generation: Research, development and  
engineering  
[PE-2524-8] 22 p0363 N79-20517

Satellite power system: Concept development and  
evaluation program, reference system report  
[NASA-TM-80413] 22 p0367 N79-21538

Evaluation of MOSTAS computer code for predicting  
dynamic loads in two bladed wind turbines  
[NASA-TM-79101] 22 p0368 N79-21549

The 1977 Goddard Space Flight Center Battery  
Workshop  
[NASA-CP-2041] 22 p0370 N79-21565

NASA's OAST program: An overview  
22 p0370 N79-21574

Effort of the Jet Propulsion Laboratory  
22 p0370 N79-21575

Solid Polymer Electrolyte (SPE) fuel cell  
technology program  
[NASA-CR-160159] 22 p0371 N79-21622

Assessment of coal cleaning technology: An  
evaluation of chemical coal cleaning processes  
[PB-289493/9] 22 p0372 N79-21625

**TECHNOLOGY TRANSFER**

Automotive engines - A viable alternative for  
aircraft  
21 p0047 A79-12379

Technology transfer at Department of Energy  
laboratories - Selected case studies from the  
Lawrence Livermore Laboratory  
21 p0099 A79-16130

How to tap NASA developed technology  
21 p0164 A79-19896

Current status and prospects for low-temperature  
solar energy  
22 p0269 A79-24623

## SUBJECT INDEX

## TEMPERATURE CONTROL

- The CCNS solar energy pilot study system performance reporting format 22 p0275 A79-25930
- The impact of aeronautical sciences on other modes of transport 22 p0325 A79-31915
- Committee on the Challenges of Modern Society Rational use of Energy Pilot Study Modular Integrated Utility Systems Project. Volume 1: Description, activities, and products [PB-283428/1] 21 p0190 A79-11549
- Committee on the challenges of modern society rational use of energy pilot study modular integrated utility system project. Volume 2: Minutes of project meeting [PB-283429/9] 21 p0191 A79-11558
- Statement of Ivan Bekey, Director of Advanced Mission Studies, Aerospace Corporation 21 p0224 A79-15107
- Baltimore applications project [NASA-TN-79667] 22 p0351 A79-18815
- TECHNOLOGY UTILIZATION**
- The Department of Energy's thermionic energy conversion program 21 p0025 A79-10213
- Engineering analysis of in situ liquefaction of coal 21 p0032 A79-10521
- Optics applied to solar energy conversion; Proceedings of the Seminar, San Diego, Calif., August 23, 24, 1977 21 p0042 A79-11965
- Activities in the field of solar cells in the Federal Republic of Germany 21 p0056 A79-13636
- Current and potential uses of aerospace technology by the U.S. Department of the Interior [AIAA PAPER 78-1716] 21 p0060 A79-13833
- Saudi Arabia looks at the sun 21 p0063 A79-13900
- Solar and wind energy applications in Hawaii 21 p0066 A79-14265
- Use of plastics in solar energy applications 21 p0067 A79-14268
- Projecting energy resource utilization - The geothermal case 21 p0068 A79-14321
- Combined environments: Technology interrelations; Proceedings of the Twenty-fourth Annual Technical Meeting, Fort Worth, Tex., April 18-20, 1978 21 p0097 A79-16076
- Co-disposal of sewage sludge using refuse-derived fuel 21 p0097 A79-16098
- Space Congress, 15th, Cocoa Beach, Fla., April 26-28, 1978, Proceedings 21 p0099 A79-16126
- A technology program for large area space systems 21 p0100 A79-16145
- National Computer Conference, Anaheim, Calif., June 5-8, 1978, Proceedings 21 p0100 A79-16177
- Possibilities for solar energy utilization in Egypt 21 p0102 A79-16453
- Solar pumping --- thermal and electrical water pumping 21 p0104 A79-16469
- Energy exchanger technology applied to laser heated engines 21 p0110 A79-16631
- Prospects for harnessing renewable energy sources in developing countries 21 p0117 A79-17286
- How to tap NASA developed technology 21 p0164 A79-19896
- Energy conservation through sealing technology 22 p0237 A79-20700
- The definition of a national program in energy-efficient pump utilization, volume 1 [BCP/W1260-01/1] 21 p0207 A79-13514
- Application of solar technology to today's energy needs, volume 2 --- systems analysis and analytical methods [OTA-E-77-VOL-2] 21 p0218 A79-14530
- Statement of Doctor Klaus Beiss, President, ECON, Incorporated, Princeton, New Jersey 21 p0224 A79-15110
- Photovoltaic power systems for rural areas of developing countries [NASA-TN-79097] 21 p0229 A79-15411
- United States civilian space programs: An overview [GPO-35-823] 21 p0232 A79-15815
- Primary lithium battery technology and its application to NASA missions [NASA-CR-158229] 22 p0354 A79-19449
- TELECOMMUNICATION**
- Solar Power Satellite (SPS) pilot beam and communication link subsystem investigation study, phase 1 --- ionospheric propagation, radio frequency interference, and microwave transmission [NASA-CR-161161] 22 p0345 A79-17896
- TELESCOPES**
- The circumsolar measurement program - Assessment of the effects of atmospheric scattering on solar energy conversion 21 p0082 A79-15077
- TELLURIC CURRENTS**
- Magnetotelluric and geoelectric measurements for geothermal exploration in the Phlegraean Fields /preliminary results/ 21 p0075 A79-14732
- Toward assessing the geothermal potential of the Jemez Mountains volcanic complex: A telluric-magnetotelluric survey [LA-7656-MS] 22 p0358 A79-20458
- TELLURIDES**
- Study of diffusion processes in low-temperature thermopiles --- for solar energy conversion 21 p0054 A79-13290
- TELLURIUM COMPOUNDS**
- Silver selenate and silver tellurate as positive materials for lithium primary power sources 22 p0245 A79-21484
- TEMPERATURE CONTROL**
- Solar Power Satellite thermal analysis 21 p0003 A79-10028
- Reducing combustion air temperature variations in magnetohydrodynamic/steam power plants 21 p0016 A79-10135
- Cooling radioisotope thermoelectric generators in the Shuttle 21 p0023 A79-10186
- Simple high-accuracy diode temperature-difference control circuit 21 p0056 A79-13631
- Evaluation of control options for solar climate control systems [AIAA PAPER 78-1758] 21 p0060 A79-13859
- A microprocessor based solar controller 21 p0082 A79-14979
- High-current power leads for tokamak fusion reactor superconducting magnets 21 p0085 A79-15318
- Controls for residential solar heating 21 p0101 A79-16418
- Controls for heat reclaim with thermal storage coupled with solar heating 21 p0102 A79-16420
- Using controls to reduce component size and energy needs for solar HVAC --- Heating Ventilation, Air Conditioning 21 p0102 A79-16421
- Theoretical and experimental analysis of a latent heat storage system --- solar energy absorbers 21 p0121 A79-17323
- A heat operated mechanical device to control the temperature and flow of water entering a hot water storage tank in a solar water heating system 21 p0140 A79-17487
- An optimal standard for solar heating systems [ASME PAPER 78-WA/DSC-19] 21 p0159 A79-19765
- A Thermic Controller for a thermic diode solar panel [ASME PAPER 78-WA/SOL-9] 21 p0163 A79-19841
- Study of the dynamics of the materials melting process for a solar furnace 21 p0167 A79-20359
- Stability of work and sensitivity of semiconductor thermoelectric systems under automatic control 22 p0261 A79-23624
- Thermal management of the lithium/metal sulfide electric vehicle [SAE PAPER 790161] 22 p0315 A79-31366
- Passive solar heating - Results from two Saskatchewan residences 22 p0322 A79-31444

## TEMPERATURE DISTRIBUTION

- Transient shutdown analysis of low-temperature thermal diodes  
[NASA-TP-1369] 22 p0346 A79-18287
- TEMPERATURE DISTRIBUTION**  
A parametric investigation on flat-plate solar collectors 21 p0128 A79-17391
- Velocity, temperature, and electrical conductivity profile in hydrogen-oxygen MHD duct flows 22 p0279 A79-26184
- Heat transfer in a solar radiation absorbing fluid layer flowing over a substrate 22 p0281 A79-26204
- TEMPERATURE EFFECTS**  
Effect of inlet temperature on the performance of a catalytic reactor 21 p0035 A79-11542
- Thermionics and its application to the SPS --- solar power satellite for energy conversion 21 p0109 A79-16616
- Temperature dependent parameter analysis of thermoelectric devices 21 p0113 A79-16740
- The thermomechanical behavior of polyvinyl butyral film and its effect on focal stability of a solar mirror-laminate 22 p0239 A79-20824
- Mixing effects of two different types of hydrides --- phase behaviors and energy storage applications 22 p0251 A79-21714
- Temperature dependence of photovoltaic solar energy conversion for GaAs homojunction solar cell 22 p0256 A79-22768
- Collisional transport --- of plasmas in plane and toroidal geometry 22 p0257 A79-22980
- Mechanism of erosion of metal electrodes of the channel of a MHD generator 22 p0306 A79-30391
- The effects of wall temperature on light impurities in Alcator --- tokamak device 22 p0313 A79-31188
- Long-term weathering effects on the thermal performance of the Libbey-Owens-Ford (liquid) solar collector [NASA-CR-161093] 22 p0348 A79-18450
- TEMPERATURE GRADIENTS**  
Solar engines - The thermal wheel and beyond 21 p0095 A79-15909
- Power generation using thermal vapor pumping and hydro-pumped storage - Thermal gradient utilization cycle /TGUC/ 21 p0095 A79-15914
- Thermal gradient-hydro generation cycle /TGUC/ 21 p0098 A79-16102
- Continental geotherms during the Archaean --- heat production in ancient earth crust 22 p0269 A79-24620
- TEMPERATURE MEASUREMENT**  
Instrumentation development for in situ coal gasification 21 p0006 A79-10053
- Instrumentation for in situ coal gasification. II - Thermal and gas sampling diagnostic techniques 21 p0032 A79-10520
- Detection of internal defects in a liquid natural gas tank by use of infrared thermography 21 p0048 A79-12507
- A comparison of the silica and Na-K-Ca geothermometers for thermal springs in Utah 21 p0097 A79-16075
- TEMPERATURE MEASURING INSTRUMENTS**  
A microprocessor compatible temperature measuring system --- for solar house energy monitoring 21 p0088 A79-15839
- Temperature calibration for solar heating and cooling system evaluation 21 p0089 A79-15846
- An inexpensive multiplexer temperature measuring system for monitoring and evaluation of solar collectors 21 p0089 A79-15847
- TEMPERATURE PROFILES**  
Dynamic behaviour of light-weight solar collectors 21 p0056 A79-13628
- Yield of ground storage of heat in solar ponds 21 p0133 A79-17429

## SUBJECT INDEX

- TEMPERATURE SENSORS**  
Sensor selection and placement in the National Solar Data Program 21 p0089 A79-15844
- TENNESSEE**  
Applying NASA remote sensing data to geologically related regional planning problems in Tennessee [E79-10095] 22 p0339 A79-17289
- TENSILE STRESS**  
Design criteria for multilayer superconductive magnets 22 p0236 A79-20536
- TERMINAL GUIDANCE**  
Procedure for flight guidance in the terminal maneuvering area for an experimental program employing a flying test device 21 p0147 A79-17680
- TERNARY SYSTEMS**  
Model predictions for the stability of ternary metallic hydrides 21 p0038 A79-11802
- TEST EQUIPMENT**  
Construction and test of a test apparatus for determining the efficiency of solar collectors with the ASE-test method 21 p0134 A79-17436
- International Instrumentation Symposium, 24th, Albuquerque, N. Mex., May 1-5, 1978, Proceedings. Parts 1 & 2 21 p0144 A79-17576
- A test bed for thermosyphon solar air collectors [AIAA PAPER 79-0541] 22 p0274 A79-25860
- TEST FACILITIES**  
Design considerations for an in situ gasification test of eastern bituminous coals 21 p0005 A79-10049
- Preliminary controller evaluation for the MFC/CTIU using a mathematical process model --- of Component Test and Integration Unit in fluidized bed combustion 21 p0008 A79-10073
- Progress in the testing of materials and design concepts for directly-fired MHD air heater service 21 p0017 A79-10141
- The Mirror Fusion Test Facility /MFTF/ 21 p0018 A79-10147
- Operating experience at the DOE/Sandia midtemperature Solar Systems Test Facility 21 p0022 A79-10182
- Five MW solar thermal test facility heliostat focus and alignment system 21 p0043 A79-11972
- Design study of superconducting magnets for a combustion magnetohydrodynamic /MHD/ generator 21 p0084 A79-15305
- Testing of solar collectors according to ASHRAE Standard 93-77 21 p0101 A79-16417
- A status report on the Solar Thermal Test Facility 21 p0112 A79-16731
- Advanced emissions control and test facility of the Electric Power Research Institute 21 p0115 A79-17249
- Testing of water-heating collectors according to ASHRAE Standard 93-77 21 p0130 A79-17410
- The USA 5MW solar thermal test facility 21 p0135 A79-17449
- Preliminary results from the Georgia Tech 400 kWth Solar Thermal Test Facility 21 p0141 A79-17499
- International Instrumentation Symposium, 24th, Albuquerque, N. Mex., May 1-5, 1978, Proceedings. Parts 1 & 2 21 p0144 A79-17576
- Master control and data system for the 5MW Solar Thermal Test Facility 21 p0144 A79-17620
- Gasification Combined Cycle Test Facility at Pekin, Illinois 21 p0145 A79-17632
- Gas stream composition and temperature determination in a coal-fired MHD simulation facility [ASME PAPER 78-WA/HT-23] 21 p0161 A79-19810
- Superconductivity for mirror fusion 22 p0236 A79-20542

# SUBJECT INDEX

# THERMAL ENERGY

- Modeling, simulation, testing, and measurements for solar energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978 22 p0266 A79-24309
- The first year of solar collector testing at Ontario Research 22 p0322 A79-31450
- Studies on solar collector performance at NRC 22 p0322 A79-31451
- Preliminary summary of the ETP conceptual studies [NASA-TM-78999] 21 p0183 A79-11478
- Battery Energy Storage Test (BEST) Facility. Phenomenological cell modeling: A tool for planning and analyzing battery testing at the BEST facility [COO-2857-1] 21 p0184 A79-11490
- MHD-ETP program. Volume 1: Executive summary [PE-2613-6-VOL-1] 22 p0362 A79-20515
- MHD-ETP program. Volume 2A, parts 1 and 2: Reference design description [PE-2613-6-VOL-2A] 22 p0363 A79-20516
- Laboratories technically qualified to test solar collectors in accordance with ASHRAE standard 93-77: A summary report [PB-289729/6] 22 p0363 A79-20524
- Engineering test facility conceptual design, part 1 [PE-2614-2-PT-1] 22 p0369 A79-21560
- Engineering test facility conceptual design, part 2 [PE-2614-2-PT-2] 22 p0369 A79-21561
- TEST FIRING**
- High pressure MHD coal combustors investigation [PE-2706-08] 22 p0362 A79-20510
- TEST STANDS**
- Large-scale cryopumping for controlled fusion 21 p0085 A79-15330
- TEST VEHICLES**
- Study of flywheel energy storage. Volume 5: Vehicle tests [PB-282656/8] 21 p0177 A79-10559
- TEXAS**
- Texas lignite: Environmental planning opportunities [PB-286870/1] 21 p0231 A79-15438
- Late diagenetic indicators of buried oil and gas. 2: Direct detection experiment at Cement and Garza fields, Oklahoma and Texas, using enhanced LANDSAT 1 and 2 images [E79-10099] 22 p0347 A79-18373
- An assessment of subsurface salt water disposal experience on the Texas and Louisiana Gulf coast for application to disposal of salt water from geopressured geothermal wells [NVO/1531-2] 22 p0366 A79-21523
- THERMAL ABSORPTION**
- Solar thermal collectors using planar reflector 21 p0131 A79-17412
- Optimising the pitching of tubes in a flat solar collector for increasing the efficiency for use in vapour absorption refrigeration 21 p0132 A79-17422
- Theoretical basis and design for a residential size solar powered ammonia/water absorption air conditioning system 21 p0139 A79-17479
- The effects of internal latent energy storage on the operational dynamics of a solar-powered absorption cycle 22 p0267 A79-24311
- The honeycomb heat trap - Its application in flat plate solar collectors 22 p0322 A79-31447
- Sensible heat storage for solar energy applications 22 p0322 A79-31449
- The first year of solar collector testing at Ontario Research 22 p0322 A79-31450
- Studies on solar collector performance at NRC 22 p0322 A79-31451
- THERMAL CONDUCTIVITY**
- Modified silicon-germanium alloys with improved performance --- thermoelectric material 21 p0027 A79-10225
- Thermal conductivity of crystalline rocks associated with energy extraction for hot dry rock geothermal systems 22 p0304 A79-30123
- Research on the physical properties of geothermal reservoir rock [COO-2908-4] 22 p0358 A79-20459
- THERMAL CONTROL COATINGS**
- Suppression of vaporization in copper-silver-selenide thermoelectric materials 21 p0027 A79-10224
- Solar-to-thermal energy converter based on coaxial evacuated tubular elements with multilayer and selective coatings 21 p0167 A79-20356
- Optical coatings for a space laser communications system 22 p0292 A79-28028
- Optical coatings for solar cells and solar collectors. Citations from the NTIS data base [NTIS/PS-78/1341/3] 22 p0350 A79-18465
- Optical coatings for solar cells and solar collectors. Citations from the Engineering index data base [NTIS/PS-78/1342/1] 22 p0350 A79-18466
- THERMAL DEGRADATION**
- Analytical predictions of selenide RTG power degradation 21 p0026 A79-10223
- Suppression of vaporization in copper-silver-selenide thermoelectric materials 21 p0027 A79-10224
- Thermal deformations of solar-energy concentrators 21 p0166 A79-20355
- Long-term weathering effects on the thermal performance of the Libbey-Owens-Ford (liquid) solar collector [NASA-CR-161093] 22 p0348 A79-18450
- THERMAL EMISSION**
- Electromagnetic radiation energy arrangement --- coatings for solar energy absorption and infrared reflection [NASA-CASE-W00-00428-1] 22 p0352 A79-19186
- THERMAL ENERGY**
- Thermal energy storage for industrial waste heat recovery 21 p0012 A79-10101
- High efficiency thermal energy storage system for utility applications 21 p0012 A79-10102
- High temperature thermal energy storage in moving sand 21 p0012 A79-10103
- NaOH-based high temperature heat-of-fusion thermal energy storage device 21 p0012 A79-10106
- Form-stable, crystalline polymer pellets for thermal energy storage 21 p0013 A79-10107
- Storage systems for solar thermal power 21 p0013 A79-10108
- Central solar heat stations and the Studsvik Demonstration Plant 21 p0021 A79-10175
- Basic physical and chemical processes for storage of heat 21 p0038 A79-11805
- Solar pond stability experiments 21 p0042 A79-11878
- Options for solar thermal conversion 21 p0043 A79-11969
- A vacuum solar thermal collector with optimal concentration 21 p0043 A79-11970
- Solar thermal electric power systems - Manufacturing cost estimation and systems optimization 21 p0046 A79-12273
- Low-grade thermal energy-conversion Joule effect heat engines [ASME PAPER 78-ENAS-7] 21 p0048 A79-12556
- Thermal energy storage heat exchanger design [ASME PAPER 78-ENAS-30] 21 p0049 A79-12579
- Development of solar thermal power plants 21 p0057 A79-13641
- Solar thermal power stations 21 p0057 A79-13644
- On the thermal and thermo-electrolytical generation of hydrogen by solar energy 21 p0059 A79-13660
- Dispersed power systems and total energy --- solar energy conversion for combined mechanical/electrical and thermal loads [AIAA PAPER 78-1770] 21 p0062 A79-13868

- Solar thermal power systems point-focusing distributed receiver /PFDR/ technology - A project description [AIAA PAPER 78-1771] 21 p0062 A79-13869
- Heat recovery devices for building HVAC systems --- Heating Ventilating and Air Conditioning 21 p0073 A79-14697
- Solar total energy systems 21 p0090 A79-15863
- Hot dry rock, an abundant clean energy resource 21 p0098 A79-16106
- A status report on the Solar Thermal Test Facility 21 p0112 A79-16731
- The economics of solar heating and cooling - A cautious view 21 p0119 A79-17297
- Long-term storage of solar energy in native rock 21 p0120 A79-17314
- A simulation study of phase change energy store 21 p0120 A79-17318
- Role of high performance solar cells in practical photovoltaic systems 21 p0122 A79-17336
- Amorphous semiconductors in photovoltaic and solar thermal conversion 21 p0122 A79-17339
- The feasibility of constructing a photoelectric unit utilizing effluent heat 21 p0125 A79-17358
- Theoretical and experimental yields of a solar heater with flat plate collectors 21 p0134 A79-17437
- Development of solar collectors for low temperature level and of concentrators for thermal and photoelectric conversion 21 p0135 A79-17445
- The USA 5MW solar thermal test facility 21 p0135 A79-17449
- Optimum insulation with internal and solar heat gains 21 p0140 A79-17490
- Medium capacity heliothermal power stations 21 p0142 A79-17507
- Use of solar energy for industrial process heat 21 p0143 A79-17524
- Master control and data system for the 5MW Solar Thermal Test Facility 21 p0144 A79-17620
- Real time computer control of 5 megawatts of solar thermal energy 21 p0144 A79-17621
- Cooling applications of thermic diode panels [ASME PAPER 78-WA/SOL-10] 21 p0163 A79-19842
- Solar-to-thermal energy converter based on coaxial evacuated tubular elements with multilayer and selective coatings 21 p0167 A79-20356
- Study of the dynamics of the materials melting process for a solar furnace 21 p0167 A79-20359
- Heat pulses required to quench a potted superconducting magnet 22 p0236 A79-20538
- Thermoclines: A solar thermal energy resource for enhanced hydroelectric power production 22 p0237 A79-20730
- Thermal storage for industrial process and reject heat 22 p0243 A79-21300
- Effects of test fluid, flow rate, and flow regime on solar collector thermal performance measurements 22 p0268 A79-24317
- A comparison of solar thermal energy collection using fixed and tracking collectors 22 p0293 A79-28146
- Chemical vapor deposited molybdenum films for use in photothermal conversion 22 p0294 A79-28148
- Chemical vapor deposited amorphous silicon for use in photothermal conversion 22 p0294 A79-28149
- A scheme for direct conversion of plasma thermal energy into electrical energy 22 p0324 A79-31765
- Thermal energy storage subsystems [NASA-CR-150812] 21 p0172 A79-10517
- Hot dry rock energy project [LA-UR-77-2744] 21 p0175 A79-10540
- Mini-Brayton heat source assembly development [NASA-CR-159447] 21 p0196 A79-12554
- A feasibility study of inorganic oxide-fluoride compositions for thermal energy storage applications [AD-A059001] 21 p0196 A79-12559
- Evaluation and targeting of geothermal energy resources in the southeastern United States [VPI-SU-5648-1] 21 p0204 A79-13478
- Conceptual design of thermal energy storage systems for near term electric utility applications. Volume 1: Screening of concepts [NASA-CR-159411-VOL-1] 21 p0205 A79-13496
- An assessment of thermal energy storage and waste heat dissipation with total energy systems for MIT [AD-A059061] 21 p0205 A79-13502
- Solar thermal test facility experiment manual [SAND-77-1173] 21 p0221 A79-14568
- Use of waste heat from thermal electric power plants and nuclear power plants to heat greenhouses [ORNL-TR-4483] 21 p0221 A79-14574
- Thermal energy transformer [NASA-CASE-WFO-14058-1] 22 p0348 A79-18443
- Thermal storage technologies for solar industrial process heat applications [NASA-TN-79130] 22 p0360 A79-20498
- THERMAL INSULATION**
- Melting multifoil insulation for KIPS emergency cooling --- Kilowatt Isotope Power System 21 p0023 A79-10191
- Characteristics of combustion-heated thermionic diodes 21 p0026 A79-10215
- Optimum insulation with internal and solar heat gains 21 p0140 A79-17490
- Solar energy and heat insulation --- materials for residential buildings 22 p0268 A79-24321
- THERMAL MAPPING**
- A time domain survey of the Los Alamos Region, New Mexico [LA-7657-MS] 22 p0365 A79-21248
- THERMAL PLASMAS**
- Auxiliary heating in breakeven tokamaks 21 p0079 A79-14792
- THERMAL POLLUTION**
- Controlling NOx from a coal-fired MHD process 21 p0017 A79-10139
- Environmental impacts of industrial energy systems in the coastal zone 21 p0075 A79-14722
- Coupled heat and organic wastes stream pollution 21 p0086 A79-15602
- Regional air pollution study: Heat emission inventory [PB-284081/7] 21 p0200 A79-12602
- THERMAL PROTECTION**
- Tests of NASA ceramic thermal barrier coating for gas-turbine engines [NASA-TN-79116] 22 p0357 A79-20118
- THERMAL RADIATION**
- A proposed thermophotovoltaic solar energy conversion system 22 p0287 A79-27317
- Design package for concentrating solar collector panels [NASA-CR-150788] 21 p0173 A79-10523
- THERMAL REACTORS**
- Thermal calculations for the reactor of a solar-power unit to produce hydrogen by thermolysis of water 21 p0167 A79-20360
- THERMAL RESISTANCE**
- Selective coatings for aluminum and steel solar absorbers 21 p0058 A79-13647
- Materials problems in solar, nuclear and storage of energy 21 p0094 A79-15901
- Determination of thermal contact resistances --- for solar thermoelectric generators 21 p0166 A79-20351
- Hot corrosion of Ni-base turbine alloys in atmospheres in coal-conversion systems 22 p0288 A79-27395



# SUBJECT INDEX

# THERMODYNAMIC CYCLES

- Gas turbine operating and maintenance experience in Saudi Arabia 22 p0298 A79-28989
- A study of the effective resistance of the diffused layer and its effect on solar cell performance 22 p0367 A79-21541
- THERMAL SIMULATION**
- Thermal modeling of coal-fired MHD plant components 21 p0017 A79-10138
- Simulation study of natural convection heat transfer in inclined air layers with application to solar energy collection 21 p0129 A79-17401
- Gas stream composition and temperature determination in a coal-fired MHD simulation facility [ASME PAPER 78-WA/HT-23] 21 p0161 A79-19810
- Limitations of solar assisted heat pump systems [ASME PAPER 78-WA/SOL-1] 21 p0162 A79-19834
- Thermal performance evaluation of the Calmac (liquid) solar collector [NASA-CR-150819] 21 p0173 A79-10521
- THERMAL STABILITY**
- Some aspects of aircraft jet engine fuels 21 p0035 A79-11368
- Space-dependent thermal stability of reacting tokamak plasmas 22 p0253 A79-22242
- THERMAL STRESSES**
- Thermal stress cracking and the enhancement of heat extraction from fractured geothermal reservoirs [LA-7235-HS] 21 p0198 A79-12568
- THERMIONIC CATHODES**
- Diminide thermionic energy conversion with lanthanum-hexaboride electrodes 21 p0053 A79-13098
- THERMIONIC CONVERTERS**
- Lithium and potassium heat pipes for thermionic converters 21 p0013 A79-10113
- Thermionic power plant design point selection - The economic impact 21 p0025 A79-10214
- Characteristics of combustion-heated thermionic diodes 21 p0026 A79-10215
- Commercial applications of thermionic conversion using a fusion reactor energy source - A preliminary assessment 21 p0026 A79-10219
- Prospects of thermionic power systems 21 p0026 A79-10220
- Diminide thermionic energy conversion with lanthanum-hexaboride electrodes 21 p0053 A79-13098
- Thermionics and its application to the SPS --- solar power satellite for energy conversion 21 p0109 A79-16616
- The advanced thermionic converter with microwave power as an auxiliary ionization source 21 p0153 A79-18470
- Optimization of a Knudsen Cs-Ba thermionic converter 22 p0241 A79-20940
- Optimization of an ideal thermionic converter 22 p0241 A79-20941
- Contribution to the theory of the pulsed mode of operation of the thermionic energy converter. II 22 p0246 A79-21542
- THERMIONIC DIODES**
- Characteristics of combustion-heated thermionic diodes 21 p0026 A79-10215
- THERMIONIC EMITTERS**
- Diminide thermionic energy conversion with lanthanum-hexaboride electrodes 21 p0053 A79-13098
- Selective covers for natural cooling devices --- in space 22 p0272 A79-25522
- THERMIONIC POWER GENERATION**
- The Department of Energy's thermionic energy conversion program 21 p0025 A79-10213
- A summary of USSR thermionic energy conversion activity 21 p0026 A79-10216
- NASA's thermionic technology program 21 p0026 A79-10217
- Increasing the efficiency of coal-fired steam electric plants with thermionic topping 21 p0096 A79-15921
- Power coupling alternatives for the NEP thermionic power system [NASA-CR-158372] 22 p0367 A79-21547
- THERMOCHEMICAL PROPERTIES**
- The efficiencies of thermochemical energy transfer 21 p0054 A79-13575
- A hybrid chemical concept for solar energy storage 22 p0254 A79-22271
- Energy storage efficiency for the ammonia/hydrogen-nitrogen thermochemical energy transfer system 22 p0261 A79-23718
- Thermochemical energy storage and transport program [SAND-78-8056] 21 p0221 A79-14570
- THERMOCHEMISTRY**
- Recent advances in thermochemical energy storage and transport 21 p0012 A79-10104
- A thermochemical energy storage system and heat pump 21 p0012 A79-10105
- Engineering and bench-scale studies of the sulfur-iodine cycle at General Atomic 21 p0015 A79-10127
- A copper oxide-copper sulfate water-splitting cycle 21 p0015 A79-10128
- Basic physical and chemical processes for storage of heat 21 p0038 A79-11805
- A hybrid thermochemical hydrogen production cycle using solar energy process heat [AIAA PAPER 78-1779] 21 p0062 A79-13874
- Solar hydrogen production at high temperatures 21 p0104 A79-16464
- Chemically driven heat pumps for solar thermal storage 21 p0120 A79-17316
- The thermochemical decomposition of water using bromine and iodine 22 p0238 A79-20770
- Problems around Fe-Cl cycles --- thermochemical decomposition of water hydrogen production 22 p0238 A79-20771
- Screening reversible reactions for thermochemical energy transfer 22 p0285 A79-26823
- Hydrogen via thermochemistry and future water-splitting technologies 22 p0289 A79-27654
- A new thermochemical process for hydrogen production 22 p0312 A79-31153
- Thermochemical production of hydrogen from water [LA-UR-78-652] 21 p0180 A79-11236
- THERMOCINES**
- Thermoclines: A solar thermal energy resource for enhanced hydroelectric power production 22 p0237 A79-20730
- Solar Total Energy Test Facility project test results: High-temperature thermocline storage subsystem [SAND-77-1528] 21 p0197 A79-12565
- THERMOCOUPLES**
- Instrumentation for in situ coal gasification. II - Thermal and gas sampling diagnostic techniques 21 p0032 A79-10520
- THERMODYNAMIC CYCLES**
- Coal-fired gas turbine power cycles with steam injection 21 p0004 A79-10042
- Hydrocarbon working fluid and operating conditions selection for the conventional geothermal binary cycle 21 p0015 A79-10124
- Effect of noncondensable gases on geothermal power generation 21 p0015 A79-10125
- Engineering and bench-scale studies of the sulfur-iodine cycle at General Atomic 21 p0015 A79-10127
- Nitinol heat engines for economical conversion of low grade thermal density 21 p0027 A79-10230
- Quasi-equilibrium Air Standard heat balanced cycle analysis 21 p0028 A79-10232

- Nitinol thermodynamic state surfaces --- heat engine material  
21 p0045 A79-12264
- The Arbonia control concept - Does flow regulation in the solar system cycle make sense --- working fluid regulation in solar heating facility  
21 p0056 A79-13632
- Solar water pumping  
21 p0066 A79-14266
- Design study of a thermohydraulic loop for the conversion of geothermal energy /low enthalpy/ into electricity  
21 p0076 A79-14741
- Thermal gradient-hydro generation cycle /TGHC/  
21 p0098 A79-16102
- Open-cycle magnetohydrodynamic electrical power generation --- Book  
21 p0104 A79-16478
- MHD power plant characteristics  
21 p0105 A79-16480
- Technical and economic aspects of open-cycle MHD power plants  
21 p0105 A79-16482
- Quasi-isentropic laser engines  
21 p0111 A79-16632
- Performance predictions of a LiBr absorption air conditioner utilizing solar energy  
21 p0139 A79-17482
- Gas-cycle solar refrigeration system performance  
21 p0153 A79-18471
- A hybrid chemical concept for solar energy storage  
22 p0254 A79-22271
- The effects of internal latent energy storage on the operational dynamics of a solar-powered absorption cycle  
22 p0267 A79-24311
- Design and optimisation of an absorption refrigeration system operated by solar energy  
22 p0285 A79-26819
- The combined reheat gas turbine/steam turbine cycle. II - The LM 5000 gas generator applied to the combined reheat gas turbine/steam turbine cycle  
[ASME PAPER 79-GT-8]  
22 p0306 A79-30506
- Some design considerations of automotive gas turbines  
[SAE PAPER 790128]  
22 p0314 A79-31360
- The use of liquid natural gas as heat sink for power cycles  
22 p0332 A79-16262
- Development of thermal prime movers for heat pump drive  
22 p0332 A79-16263
- THERMODYNAMIC EFFICIENCY**
- Geothermal preheating in fossil-fired steam power plants  
21 p0014 A79-10118
- Thermal performance trade-offs for point focusing solar collectors  
21 p0020 A79-10165
- Measurement of heat loss from a heat receiver assembly of a Fixed Mirror Solar Concentrator  
21 p0020 A79-10166
- The Pseudo Stirling cycle - A suitable performance criterion  
21 p0023 A79-10196
- Influence of cyclic wall-to-gas heat transfer in the cylinder of the valved hot-gas engine  
21 p0024 A79-10201
- Conversion of a standard single cylinder I.C. engine into a 'gamma' configuration air charged Stirling engine  
21 p0024 A79-10202
- Research on the sodium heat engine  
21 p0028 A79-10231
- Quasi-equilibrium Air Standard heat balanced cycle analysis  
21 p0028 A79-10232
- The efficiencies of thermochemical energy transfer  
21 p0054 A79-13575
- Absorption of solar radiation by alkali vapors --- for efficient high temperature energy converters  
21 p0108 A79-16612
- A high temperature Rankine binary cycle for ground and space solar engine applications  
21 p0108 A79-16613
- Solar energy and the second law of thermodynamics  
21 p0118 A79-17292
- The French CNRS 1 MW solar power plant  
21 p0141 A79-17498
- Two thermodynamic optima in the design of sensible heat units for energy storage  
21 p0150 A79-18091
- Efficiency improvement by means of multicomponent processes - Improvement of the efficiency of heat-power transformation by means of an employment of Clausius-Rankine sorption processes  
21 p0164 A79-19975
- Problems around Fe-Cl cycles --- thermochemical decomposition of water hydrogen production  
22 p0238 A79-20771
- Storage efficiency in a solar plant  
22 p0254 A79-22270
- The cryogenic heat transfer tunnel - A new tool for convective research --- thermal efficiency testing of solar tower receiver  
22 p0267 A79-24316
- Analysis and design of air heating unglazed flat plate solar collectors  
22 p0280 A79-26202
- Analysis of energy storage by phase change with an array of cylindrical tubes  
22 p0281 A79-26207
- Heat loss characteristics of an evacuated plate-in-tube collector  
22 p0285 A79-26811
- Design and optimisation of an absorption refrigeration system operated by solar energy  
22 p0285 A79-26819
- Screening reversible reactions for thermochemical energy transfer  
22 p0285 A79-26823
- Thermodynamic basis for combining cycles of heat producing power plants  
22 p0298 A79-29297
- Ways of improving steam-gas power plants --- fuel economy  
22 p0299 A79-29298
- Thermodynamics of the conversion of diluted radiation --- solar energy application  
22 p0310 A79-30910
- A new thermochemical process for hydrogen production  
22 p0312 A79-31153
- Direct thermomagnetic splitting of water  
22 p0312 A79-31154
- MHD gas turbine energy conversion for mirror fusion reactors  
22 p0313 A79-31192
- Thermal performance evaluation of a flat-plate cylindrical parabolic concentrator and a flat-plate collector  
22 p0317 A79-31408
- A solar collector thermal performance test for developmental programs  
22 p0317 A79-31413
- The first year of solar collector testing at Ontario Research  
22 p0322 A79-31450
- Thermal performance evaluation of the Solargenics solar collector at outdoor conditions  
[NASA-CR-150857]  
21 p0228 A79-15401
- Experimental verification of a standard test procedure for solar collectors  
[PB-289912/8]  
22 p0372 A79-21632
- THERMODYNAMIC EQUILIBRIUM**
- Model predictions for the stability of ternary metallic hydrides  
21 p0038 A79-11802
- Feasible operating regions for moving bed coal gasification reactors  
22 p0297 A79-28983
- THERMODYNAMIC PROPERTIES**
- Solar Power Satellite thermal analysis  
21 p0003 A79-10028
- Thermodynamic and kinetic considerations on zinc-halogen batteries  
21 p0040 A79-11822
- Nitinol thermodynamic state surfaces --- heat engine material  
21 p0045 A79-12264
- Alternative aviation turbine fuels  
21 p0047 A79-12378
- Dynamic behaviour of light-weight solar collectors  
21 p0056 A79-13628

# SUBJECT INDEX

# THERMOELECTRIC POWER GENERATION

- Design of a solar energy operated lithium-bromide water absorption refrigeration system for refrigeration storage 21 p0143 A79-17523
- Selection of thermal operating regimes for fuel cell reactor-condenser systems 21 p0165 A79-20342
- Thermodynamics of pressure plateaus in metal-hydrogen systems 22 p0238 A79-20772
- Thermodynamics of metal, alloy and intermetallic/hydrogen systems 22 p0248 A79-21680
- High temperature thermodynamics of the solid solutions of hydrogen and deuterium in palladium and in the Pd/O.9/Ag/O.1/ alloy 22 p0249 A79-21689
- Synthesis and properties of useful metal hydrides - A review of recent work at Brookhaven National Laboratory 22 p0250 A79-21699
- Hydride formation of C14-type Ti alloy 22 p0250 A79-21701
- On an irreversible thermodynamic analysis of thermoelectric devices 22 p0260 A79-23609
- Thermal management of the lithium/metal sulfide electric vehicle [SAE PAPER 790161] 22 p0315 A79-31366
- Analytical methods for evaluating two-dimensional effects in flat-plate solar collectors 21 p0181 A79-11462
- Thermal analysis of receivers for solar concentrators and optimization procedure for power production 21 p0182 A79-11465
- Long-term weathering effects on the thermal performance of the Lennox/Honeywell (liquid) solar collector [NASA-CR-150818] 21 p0204 A79-13493
- LARGO hot water system thermal performance test report [NASA-CR-150841] 21 p0205 A79-13500
- Thermal and kinetic analysis of the pyrolysis of coals 22 p0336 A79-16704
- A two-dimensional thermal analysis of a new high-performance tubular solar collector 22 p0352 A79-19060
- Thermal and other tests of photovoltaic modules performed in natural sunlight [NASA-CR-158174] 22 p0354 A79-19460
- Long term weathering effects on the thermal performance of the solaron (air) solar collector [NASA-CR-161166] 22 p0371 A79-21621
- THERMODYNAMICS**
- A thermodynamic study of heating with geothermal energy [ASHE PAPER 77-WA/ENEB-1] 21 p0030 A79-10253
- THERMOELASTICITY**
- Thermoelastic solutions for in-situ gasification of coal 22 p0330 A79-16135
- THERMOELECTRIC GENERATORS**
- Selenide isotope generator for the Galileo mission 21 p0022 A79-10185
- Cooling radioisotope thermoelectric generators in the Shuttle 21 p0023 A79-10186
- The application of solar thermoelectric generators in near-sun missions 21 p0023 A79-10187
- Copper/water axially-grooved heat pipes for RTG applications 21 p0023 A79-10188
- Development of a 1 kW/e/ isotope fueled Stirling cycle power system 21 p0025 A79-10210
- Selenide thermoelectric converter technology 21 p0026 A79-10221
- Selenide technology evaluation program at JPL 21 p0026 A79-10222
- Recent terrestrial and undersea applications of radioisotope thermoelectric generators /RTGs/ 21 p0027 A79-10226
- Militarized thermoelectric power sources 21 p0027 A79-10227
- High reliability contacts for miniature thermoelectric converters 21 p0027 A79-10228
- Solar furnace type high power density thermoelectric generator 21 p0027 A79-10229
- Research on the sodium heat engine 21 p0028 A79-10231
- An analysis of a cylindrical parabolic focussing collector for distributed collector power systems 21 p0134 A79-17442
- Development of solar collectors for low temperature level and of concentrators for thermal and photoelectric conversion 21 p0135 A79-17445
- The attainable efficiency of the solar thermoelectric generators 21 p0140 A79-17496
- Determination of thermal contact resistances --- for solar thermoelectric generators. 21 p0166 A79-20351
- Thermal converters with transverse thermoelectromotive forces 22 p0256 A79-22847
- On an irreversible thermodynamic analysis of thermoelectric devices 22 p0260 A79-23609
- Design concepts of solar thermoelectric generators in space applications 22 p0260 A79-23612
- Optimization method of isotopic thermoelectric microgenerator geometry 22 p0260 A79-23613
- Some effects of leg surface heat losses on the performance of a p-n type thermoelectric generator 22 p0260 A79-23616
- Efficiency of a series of thermoelectric generators in a solar wedge concentrator 22 p0260 A79-23618
- Determining the reliability of radioisotope thermoelectric generators /RTGs/ designed for terrestrial and undersea applications 22 p0261 A79-23622
- Recent terrestrial and undersea applications of radioisotope thermoelectric generators /RTGs/ 22 p0261 A79-23623
- Stability of work and sensitivity of semiconductor thermoelectric systems under automatic control 22 p0261 A79-23624
- Solar thermal electric power systems - Comparison of line-focus collectors 22 p0263 A79-23758
- THERMOELECTRIC MATERIALS**
- Selenide thermoelectric converter technology 21 p0026 A79-10221
- Analytical predictions of selenide RTG power degradation 21 p0026 A79-10223
- Suppression of vaporization in copper-silver-selenide thermoelectric materials 21 p0027 A79-10224
- Modified silicon-germanium alloys with improved performance --- thermoelectric material 21 p0027 A79-10225
- Recent terrestrial and undersea applications of radioisotope thermoelectric generators /RTGs/ 21 p0027 A79-10226
- Comprehensive thermoelectric properties of n- and p-type 78a/o Si - 22a/o Ge alloy 22 p0259 A79-23604
- Method of producing a p-type or n-type alloy for direct thermoelectric energy conversion 22 p0260 A79-23615
- Regenerative burner system for thermoelectric power sources 22 p0261 A79-23621
- Determining the reliability of radioisotope thermoelectric generators /RTGs/ designed for terrestrial and undersea applications 22 p0261 A79-23622
- THERMOELECTRIC POWER GENERATION**
- Circulating-bed boiler concepts for steam and power generation 21 p0008 A79-10071
- Comparative evaluation of distributed-collector solar thermal electric power plants 21 p0021 A79-10173

- Brayton Isotope Power System - The versatile dynamic power converter --- for spacecraft  
21 p0023 A79-10190
- Melting multifoil insulation for KIPS emergency cooling --- Kilowatt Isotope Power System  
21 p0023 A79-10191
- Study of diffusion processes in low-temperature thermopiles --- for solar energy conversion  
21 p0054 A79-13290
- A central receiver solar thermal power system  
21 p0091 A79-15872
- 10-megawatt solar central receiver pilot plant  
21 p0094 A79-15906
- Temperature dependent parameter analysis of thermoelectric devices  
21 p0113 A79-16740
- Solar thermal conversion installations in the medium power range - The Thek project  
22 p0254 A79-22269
- International Conference on Thermoelectric Energy Conversion, 2nd, University of Texas, Arlington, Tex., March 22-24, 1978, Proceedings and Supplement  
22 p0259 A79-23603
- Estimating heat loads on multistage thermoelectric heat pumps  
22 p0260 A79-23614
- Reversible thermoelectric power conversion of energy fluctuations  
22 p0261 A79-23619
- Regenerative burner system for thermoelectric power sources  
22 p0261 A79-23621
- Thermoelectric magnetohydrodynamics  
22 p0312 A79-31098
- Solar power plants --- thermoelectric conversion in Canada  
22 p0318 A79-31416
- THERMOELECTRICITY**  
On an irreversible thermodynamic analysis of thermoelectric devices  
22 p0260 A79-23609
- The effect of thermo-electric forces on the density profiles in a thermonuclear plasma surrounded by a cold blanket  
22 p0292 A79-27886
- THERMOGRAVIMETRY**  
Design study of a thermohydraulic loop for the conversion of geothermal energy /low enthalpy/ into electricity  
21 p0076 A79-14741
- THERMOHYDRAULICS**  
Design study of a thermohydraulic loop for the conversion of geothermal energy /low enthalpy/ into electricity  
21 p0076 A79-14741
- Geothermal power and water production studies at the University of California  
[ASME PAPER 78-WA/ENER-7] 21 p0159 A79-19778
- THERMOMAGNETIC EFFECTS**  
Direct thermomagnetic splitting of water  
22 p0312 A79-31154
- THERMOMECHANICAL TREATMENT**  
The thermomechanical behavior of polyvinyl butyral film and its effect on focal stability of a solar mirror-laminate  
22 p0239 A79-20824
- THERMOMETERS**  
A comparison of the silica and Na-K-Ca geothermometers for thermal springs in Utah  
21 p0097 A79-16075
- THERMONUCLEAR POWER GENERATION**  
Controlled thermonuclear fusion  
22 p0287 A79-27339
- Relaxation of a fast ion beam in a tokamak plasma  
22 p0324 A79-31760
- THERMONUCLEAR REACTIONS**  
Hybrid reactor based on laser-induced thermonuclear fusion  
21 p0032 A79-10658
- Problems in the use of cryogenic pumps in thermonuclear synthesis  
22 p0305 A79-30264
- Hydrogen technology from thermonuclear research  
22 p0338 A79-16997
- THERMOPHYSICAL PROPERTIES**  
Investigation of the thermophysical characteristics of cryogenic heat pipes with a metal-fiber wick  
22 p0288 A79-27529
- Dependence of the pour point of diesel fuels on the properties of the initial components  
[NASA-TN-75424] 22 p0364 A79-21217
- THERMOPILES**  
Solar furnace type high power density thermoelectric generator  
21 p0027 A79-10229
- Study of diffusion processes in low-temperature thermopiles --- for solar energy conversion  
21 p0054 A79-13290
- THERMOREGULATION**  
A Thermic Controller for a thermic diode solar panel  
[ASME PAPER 78-WA/SOL-9] 21 p0163 A79-19841
- THERMOSYPHONS**  
Thermosyphon solar water heating system under Brazilian conditions  
21 p0021 A79-10177
- Passive solar design --- for domestic heating and cooling systems  
21 p0074 A79-14720
- A passive rock bed - Design, construction, and performance  
21 p0121 A79-17328
- Investigation on the feasibility of using a two-phase thermosyphon for solar storage, space heating and cooking  
21 p0121 A79-17330
- A heat operated mechanical device to control the temperature and flow of water entering a hot water storage tank in a solar water heating system  
21 p0140 A79-17487
- Thermosyphon models for downhole heat exchanger applications in shallow geothermal systems  
21 p0150 A79-18092
- A theoretical analysis of solar collector/storage panels  
[ASME PAPER 78-WA/SOL-11] 21 p0163 A79-19843
- Experiments with a flat plate solar water heating system in thermosyphonic flow  
22 p0262 A79-23755
- Effects of low solar input and amount of storage on thermosyphon hot water system performance  
22 p0267 A79-24312
- A test bed for thermosyphon solar air collectors  
[AIAA PAPER 79-0541] 22 p0274 A79-25860
- THERMOSTATS**  
Controls for residential solar heating  
21 p0101 A79-16418
- THETA PINCH**  
Fast penetration of a magnetic field into a low-density plasma  
22 p0244 A79-21432
- Theory of the striated corona in a theta pinch  
22 p0295 A79-28315
- 200-kv Blumlein transmission line for ultrafast toroidal theta-pinch  
22 p0297 A79-28917
- THICK FILMS**  
Development of economical improved thick film solar cell contact  
[NASA-CR-158358] 22 p0359 A79-20486
- THICK WALLS**  
On the optimisation of Trombe wall solar collectors  
[ASME PAPER 78-WA/SOL-13] 21 p0163 A79-19845
- THIN FILMS**  
Sprayed CdS thin films for CdS/Cu<sub>2</sub>S heterojunction solar cells  
21 p0123 A79-17346
- Stoichiometric Cu<sub>2</sub>S thin films for solar cells  
21 p0123 A79-17349
- A pilot line for the production of large area Cu<sub>x</sub>/S-CdS solar cells  
21 p0124 A79-17351
- Photoelectric properties of pCdTe-nCdS film heterojunctions  
21 p0166 A79-20347
- Heat exchanges and columnar growth in electron-beam evaporation of silicon films for solar cell applications  
22 p0272 A79-25084
- High-efficiency thin-film polycrystalline-silicon solar cells  
22 p0273 A79-25744

# SUBJECT INDEX

# TOKAMAK DEVICES

- Chemical vapor deposited molybdenum films for use in photothermal conversion 22 p0294 A79-28148
- The design and fabrication of CdS/Cu<sub>2</sub>S cells of 8.5-percent conversion efficiency 22 p0300 A79-29428
- Low cost thin-film CdS-based solar cells progress and promise [ASME PAPER 79-SOL-15] 22 p0309 A79-30549
- Evaluation of the technical feasibility and effective cost of various wafer thicknesses for the manufacture of solar cells [NASA-CR-158095] 22 p0334 A79-16368
- Thin film battery/fuel cell power generating system [CONS/1197-9] 22 p0369 A79-21556
- THIN PLATES**
- Development of an improved high efficiency thin silicon solar cell [NASA-CR-158172] 22 p0354 A79-19459
- THIOLS**
- Behavior of nonmetallic materials in shale oil derived jet fuels and in high aromatic and high sulfur petroleum fuels --- compatibility of aircraft materials to fuels [AD-A060322] 21 p0226 A79-15203
- THOMSON SCATTERING**
- Laser measurements of the radial profiles of the electron temperature and density in the FT-1 tokamak 22 p0244 A79-21430
- THORIUM**
- Nonproliferation Alternative Systems Assessment Program (NASAP): Preliminary environmental assessment of thorium/uranium fuel cycle systems [ORNL/TM-6069] 21 p0192 A79-11570
- THYRISTORS**
- Thyristor controlled rectifier inverting at unity power factor 21 p0033 A79-10898
- Efficient use of wind energy by using static slip recovery systems - A simulator study 21 p0113 A79-16744
- Superconducting energy storage magnets 22 p0236 A79-20537
- TIDE POWERED GENERATORS**
- Tidal power plants - Sites, history and geographical distribution 21 p0150 A79-18102
- Selection of optimum sites for tidal power development in the Bay of Fundy 21 p0152 A79-18110
- The economics of Fundy tidal power 21 p0152 A79-18112
- Principles of design and construction for marine structures for wave/tidal/ocean thermal energy 21 p0152 A79-18114
- Studies in retining tidal energy 21 p0152 A79-18115
- The role of tidal power stations in future scenarios for electricity storage in U.K. 21 p0152 A79-18116
- Tidal power in the Bay of Fundy 22 p0237 A79-20729
- Harnessing tidal energy [PB-286671/3] 21 p0222 A79-14581
- TIDEPower**
- Potential and technical utilization of renewable energy sources 21 p0058 A79-13655
- Wind, waves, and tides --- as future energy sources 21 p0074 A79-14719
- International Symposium on Wave and Tidal Energy, University of Kent, Canterbury, England, September 27-29, 1978, Proceedings. Volume 1 21 p0150 A79-18101
- Review of optimization and economic evaluation of potential tidal power developments in the Bay of Fundy 21 p0152 A79-18111
- Prefabricated Caissons for tidal power development 21 p0152 A79-18113
- TIDES**
- A numerical model investigation of tidal phenomena in the Bay of Fundy and Gulf of Maine 22 p0323 A79-31554
- TIMBER INVENTORY**
- PLANE: Forestry Lands Allocated for Managing energy. Feasibility study [AD-A059993] 21 p0217 A79-14507
- TIME DEPENDENCE**
- Torque ripple in a vertical axis wind turbine 21 p0029 A79-10239
- Yield of ground storage of heat in solar ponds 21 p0133 A79-17429
- TIN OXIDES**
- Potential for low cost, high efficiency solar cells using indium tin oxide on semiconductor /OSOS/ solar cells 21 p0122 A79-17338
- Transparent conducting coatings for solar cells 21 p0124 A79-17350
- Angle-of-incidence effects in electron-beam-deposited SnO<sub>2</sub>/Si solar cells 22 p0272 A79-25069
- TITANIUM**
- Discharge characteristics of a soluble iron-titanium battery system 22 p0286 A79-26996
- Supply of reactants for Redox bulk energy storage systems [NASA-TM-78995] 21 p0183 A79-11479
- TITANIUM ALLOYS**
- New alloy systems for hydrogen storage 21 p0038 A79-11806
- Hydride formation of C14-type Ti alloy 22 p0250 A79-21701
- The iron-titanium - hydrogen system: A transmission electron microscope /TEM/ study 22 p0285 A79-26947
- TITANIUM COMPOUNDS**
- Electronic structure and physical properties of Ti-H and Zr-H using NMR 22 p0248 A79-21685
- The use of FeTi-hydride for production and storage of suprapure hydrogen 22 p0250 A79-21700
- TITANIUM OXIDES**
- Study of the interaction of H<sub>2</sub>O and C<sub>2</sub> with the surface of TiO<sub>2</sub> by electron stimulated desorption and Auger and characteristic loss spectroscopies 21 p0037 A79-11793
- TITRATION**
- An improved method for analysis of hydroxide and carbonate in alkaline electrolytes containing zinc 21 p0035 A79-11546
- TOKAMAK DEVICES**
- Doublet III design and construction --- Tokamak fusion research device 21 p0018 A79-10145
- Demonstration and commercial prototype tokamak reactors 21 p0018 A79-10146
- On the ion energy balance in TFR with and without neutral injection heating 21 p0069 A79-14452
- Recent results from the PLT tokamak 21 p0069 A79-14453
- Review of tokamak theory results 21 p0069 A79-14454
- Progress in tokamak experimental research in the Soviet Union 21 p0069 A79-14455
- Review of results from DITE tokamak 21 p0069 A79-14456
- Experiments on adiabatic compression of a tokamak plasma in Tusan-2 21 p0069 A79-14457
- Toroidal high-beta systems 21 p0070 A79-14462
- Present status of two R.F. heating schemes - I.C.R.H. and L.R.H. --- Ion Cyclotron Resonant Heating and Lower-Hybrid Resonant Heating of plasma 21 p0071 A79-14467
- Tokamak reactors for breakeven: A critical study of the near-term fusion reactor program --- Book 21 p0077 A79-14776
- Review of experimental results. I, II --- MHD instability effects on tokamak confinement with ohmic heating 21 p0077 A79-14778
- MHD equilibrium and stability --- in tokamak devices 21 p0078 A79-14779
- Collisional transport --- particle diffusion and heat transport in tokamak 21 p0078 A79-14780

- Magnetic divertors --- in large tokamak plasma confinement experiments 21 p0078 A79-14781
- The 'PINTOR 1' design - A minimum size tokamak experimental reactor 21 p0078 A79-14782
- Philosophy and physics of predemonstration fusion devices 21 p0078 A79-14783
- Characteristics of a predemonstration fusion device 21 p0078 A79-14784
- Compact experiments for alpha-particle heating --- of confined D-T plasma in tokamak 21 p0078 A79-14786
- Superconducting magnet systems in EPR designs --- Experimental Power Reactor 21 p0079 A79-14789
- Materials problems and possible solutions for near term tokamak fusion reactors 21 p0079 A79-14790
- Energy sources and conventional magnets --- for tokamak experiment Power Reactor toroidal field 21 p0079 A79-14791
- Auxiliary heating in breakeven tokamaks 21 p0079 A79-14792
- The impact of servicing requirements on tokamak fusion reactor design 21 p0079 A79-14793
- Fusion power by magnetic confinement - Program plan 21 p0080 A79-14794
- High-current power leads for tokamak fusion reactor superconducting magnets 21 p0085 A79-15318
- Large-scale cryopumping for controlled fusion 21 p0085 A79-15330
- Dynamics and feedback control of ISX tokamak 21 p0107 A79-16559
- Energy storage for tokamak reactor cycles --- during downtime for periodic plasma quench and reignition 21 p0111 A79-16727
- Radially resolved measurements of 'q' on the adiabatic toroidal compressor tokamak --- safety factor 21 p0155 A79-18830
- The role of the Large Coil Program in the development of superconducting magnets for fusion reactors 22 p0236 A79-20541
- Conceptual design of a superconducting tokamak - 'TORUS II SUPRA' 22 p0236 A79-20543
- SLPX - Superconducting Long-Pulse Tokamak Experiment 22 p0237 A79-20557
- Effect of the magnetic configuration of the poloidal diverter on the plasma in the T-12 finger-ring tokamak 22 p0244 A79-21429
- Laser measurements of the radial profiles of the electron temperature and density in the FT-1 tokamak 22 p0244 A79-21430
- Measurements of plasma rotation in tokamak LT-3 22 p0252 A79-22238
- Empirical scaling laws for energy confinement in ohmically-heated tokamaks 22 p0253 A79-22240
- Space-dependent thermal stability of reacting tokamak plasmas 22 p0253 A79-22242
- Alpha transport and blistering in tokamaks 22 p0253 A79-22243
- A simple neutral density profile calculation for tokamaks with  $\lambda_{sub}$  mfp much smaller than a 22 p0255 A79-22379
- Wave reflection from the lower hybrid surface - A toroidal effect --- in tokamaks 22 p0255 A79-22427
- Non-linear numerical algorithms for studying tearing modes --- in tokamaks 22 p0257 A79-22981
- MHD instabilities 22 p0259 A79-23599
- Stability criteria for current-driven drift wave eigenmodes --- in tokamaks 22 p0269 A79-24813
- Parametric decay of lower hybrid waves in a plasma - Effect of ion nonlinearity --- in tokamaks 22 p0269 A79-24814
- Electrons of high perpendicular energy in the low-density regime of tokamaks 22 p0270 A79-24852
- Non-thermal emission at the plasma frequency --- spectra obtained on tokamak fusion reactors 22 p0270 A79-24854
- Quasi-linear theory of heat flow and diffusion in a tokamak 22 p0270 A79-24859
- RF-heating in stationary systems --- of toroidal plasma in tokamaks 22 p0271 A79-24864
- Lower hybrid resonance heating --- of tokamak plasma 22 p0271 A79-24865
- Magneto-acoustic resonance heating in the ion-cyclotron frequency domain --- of tokamak plasmas 22 p0271 A79-24866
- The potential of fusion reactors as process heat source 22 p0284 A79-26624
- Doublet III --- tokamak program review 22 p0290 A79-27667
- The Alcator liquid nitrogen-cooled tokamaks 22 p0290 A79-27668
- Status report on TFTR --- Toroidal Fusion Test Reactor 22 p0290 A79-27669
- Recombination-induced neutral-particle flux in tokamaks 22 p0291 A79-27877
- On the motion of runaway electrons in momentum space --- analysis for multi-component plasma in tokamaks 22 p0291 A79-27880
- Characteristics of electron-cyclotron-resonance-heated tokamak power reactors 22 p0292 A79-27885
- 200-kv Blumlein transmission line for ultrafast toroidal theta-pinch 22 p0297 A79-28917
- Feasibility of MHD-ac induction electric power plant --- using tokamak reactor exhaust plasma 22 p0303 A79-29794
- The contribution of plasma dielectric properties to the cyclotron radiation spectrum from a tokamak plasma 22 p0312 A79-31183
- Interpretation of cyclotron radiation spectra from runaway discharges in TFR 22 p0313 A79-31185
- A ray-tracing analysis of fast-wave heating of tokamaks 22 p0313 A79-31186
- The effects of wall temperature on light impurities in Alcator --- tokamak device 22 p0313 A79-31188
- Large tokamak experiments - Report on the Third IAEA Technical Committee Meeting, Paris, 1-6 September 1978 22 p0313 A79-31193
- Relaxation of a fast ion beam in a tokamak plasma 22 p0324 A79-31760
- Experiments on controlling the plasma density in the TO-1 tokamak 22 p0324 A79-31762
- Calculation of the Q factor for a two-component tokamak 22 p0324 A79-31763
- Heat transport near the wall of a tokamak reactor 22 p0324 A79-31764
- The JFT project - A step towards the production of power by nuclear fusion 22 p0326 A79-31918
- Four ignition TNS Tokamak reactor systems: Design summary [ORNL/SUB-7117/25] 21 p0193 N79-11889
- Parametric requirements for noncircular Tokamak commercial fusion plants [GA-A-14876] 21 p0214 N79-13871
- Parametric requirements for noncircular Tokamak commercial fusion plants [GA-A-14946] 21 p0214 N79-13872

## TOPOGRAPHY

- Atlas of western surface-mined lands: Coal, uranium, and phosphate [PB-287846/0] 22 p0340 N79-17311

# SUBJECT INDEX

# TRACE CONTAMINANTS

## TORNADOES

Some flow analyses for Tornado-type wind turbines  
22 p0279 A79-26181

## TOROIDAL PLASMAS

Recent results from the PLI tokamak  
21 p0069 A79-14453

Heating and confinement in the CLEO stellarator  
21 p0070 A79-14459

Toroidal high-beta systems  
21 p0070 A79-14462

New results in high-beta stellarator and  
belt-pinch research  
21 p0070 A79-14463

Present status of two R.F. heating schemes -  
I.C.R.H. and L.H.R.H. --- Ion Cyclotron Resonant  
Heating and Lower-Hybrid Resonant Heating of  
plasma  
21 p0071 A79-14467

MHD equilibrium and stability --- in tokamak devices  
21 p0078 A79-14779

Collisional transport --- particle diffusion and  
heat transport in tokamak  
21 p0078 A79-14780

The 'PINTOR 1' design - A minimum size tokamak  
experimental reactor  
21 p0078 A79-14782

Superconducting magnets - Some fundamentals and  
their state of the art  
21 p0079 A79-14788

Superconducting magnet systems in FPR designs ---  
Experimental Power Reactor  
21 p0079 A79-14789

Energy sources and conventional magnets --- for  
tokamak experiment Power Reactor toroidal field  
21 p0079 A79-14791

Flywheel energy storage system for JT-60 toroidal  
field coil  
21 p0112 A79-16729

Radially resolved measurements of 'q' on the  
adiabatic toroidal compressor tokamak --- safety  
factor  
21 p0155 A79-18830

Design of a D-shaped toroidal field coil  
21 p0156 A79-19083

Conceptual design of a superconducting tokamak -  
'TORUS II SUPRA'  
22 p0236 A79-20543

SLPX - Superconducting Long-Pulse Tokamak Experiment  
22 p0237 A79-20557

Measurements of plasma rotation in tokamak JT-3  
22 p0252 A79-22238

Wave reflection from the lower hybrid surface - A  
toroidal effect --- in tokamaks  
22 p0255 A79-22427

Equilibrium relations in the presence of arbitrary  
plasma diffusion in axisymmetric configurations  
22 p0257 A79-22979

Collisional transport --- of plasmas in plane and  
toroidal geometry  
22 p0257 A79-22980

MHD instabilities  
22 p0259 A79-23599

Electron cyclotron heating in high density  
toroidal plasmas  
22 p0265 A79-24037

Asymptotic theory of dissipative trapped electron  
mode overlapping many rational surfaces --- in  
toroidal plasmas  
22 p0270 A79-24855

Integral invariants and quasi-MHD nonlinear  
dissipation --- in magnetized toroidal plasmas  
22 p0270 A79-24862

MHD stability for a spherator with a purely  
poloidal magnetic field  
22 p0271 A79-24863

RF-heating in stationary systems --- of toroidal  
plasma in tokamaks  
22 p0271 A79-24864

Lower hybrid resonance heating --- of tokamak plasma  
22 p0271 A79-24865

Wave propagation and absorption near the  
electron-cyclotron layer in the 'THOR' device  
--- microwave heating of tokamak plasma  
22 p0271 A79-24867

Macroscopic stability and beta limit in the ELMO  
Bumpy Torus  
22 p0291 A79-27876

Theory of dissipative drift instabilities in  
sheared magnetic fields --- in confined toroidal  
plasmas  
22 p0292 A79-27884

Characteristics of  
electron-cyclotron-resonance-heated tokamak  
power reactors  
22 p0292 A79-27885

200-kv Blumlein transmission line for ultrafast  
toroidal theta-pinch  
22 p0297 A79-28917

Design and development of the US-TESPE toroidal coil  
22 p0311 A79-31014

The contribution of plasma dielectric properties  
to the cyclotron radiation spectrum from a  
tokamak plasma  
22 p0312 A79-31183

Radial transport in the ELMO Bumpy Torus in  
collisional regimes  
22 p0312 A79-31184

A ray-tracing analysis of fast-wave heating of  
tokamaks  
22 p0313 A79-31186

Relaxation of a fast ion beam in a tokamak plasma  
22 p0324 A79-31760

Experiments on controlling the plasma density in  
the TO-1 tokamak  
22 p0324 A79-31762

Calculation of the Q factor for a two-component  
tokamak  
22 p0324 A79-31763

Dynamic stabilization of toroidal discharges in  
weak longitudinal magnetic fields  
22 p0324 A79-31766

The JET project - A step towards the production of  
power by nuclear fusion  
22 p0326 A79-31918

The formulation of the wall stabilization problem  
of an axisymmetrical toroidal sharp-boundary  
plasma with a horizontally elongated noncircular  
cross section  
22 p0327 A79-32103

## TOROIDS

Toroidal accelerator rotor platforms for wind  
energy conversion  
21 p0077 A79-14770

## TORQUE

Torque ripple in a vertical axis wind turbine  
21 p0029 A79-10239

Solar engines - The thermal wheel and beyond  
21 p0095 A79-15909

Field testing of 5-kW commercial wind generator  
with an automatic load-matching device for  
utilizing its output  
21 p0143 A79-17515

## TOWERS

Development of solar thermal power plants  
21 p0057 A79-13641

Wind turbine generator application places unique  
demands on tower design and materials  
22 p0240 A79-20826

## TOXIC HAZARDS

A literature review-problem definition studies on  
selected toxic chemicals. Volume 1:  
Occupational health and safety aspects of diesel  
fuel and white smoke generated from it  
[AD-A056018]  
21 p0192 A79-11686

Measured air flow rates through microorifices and  
flow prediction capability  
[PB-286868/5]  
21 p0217 A79-14344

## TOXICITY

Toxic component concentration in kerosene-air  
mixture combustion products  
22 p0291 A79-27733

## TOXICITY AND SAFETY HAZARD

A literature review-problem definition studies on  
selected toxic chemicals. Volume 8:  
Environmental aspects of diesel fuel and fog  
oils SGP number 1 and SGP number 2 and smoke  
screens generated from them  
[AD-A056021]  
21 p0193 A79-11688

## TOXICOLOGY

Health effects associated with diesel exhaust  
emissions, literature review and evaluation  
[PB-289817/9]  
22 p0364 A79-20727

## TRACE CONTAMINANTS

A mass and energy balance of a Wellman-Galusha  
gasifier --- bituminous coal conversion  
22 p0283 A79-26467

## TRACE ELEMENTS

## TRACE ELEMENTS

- The fate of trace elements in coal after combustion  
21 p0116 A79-17250
- Trace element emissions from coal-fired power plants  
[ASME PAPER 78-WA/FU-9] 21 p0160 A79-19789
- Chemical studies of stack fly ash from a coal-fired power plant  
22 p0309 A79-30595
- Trace element characterization and removal/recovery from coal and coal wastes  
[IA-7048-PR] 21 p0222 N79-14602
- TRACKING (POSITION)**
- Annual available radiation for fixed and tracking collectors  
21 p0042 A79-11880
- Design of a second generation concentrating tracking solar collector  
[AIAA PAPER 78-1775] 21 p0062 A79-13872
- Tracking high temperature collectors  
21 p0090 A79-15856
- Simple procedure for predicting long term average performance of nontracking and of tracking solar collectors  
21 p0091 A79-15873
- The design and evaluation of a hydraulic-solar powered tracking device  
21 p0136 A79-17458
- Efficiency degradation due to tracking errors for point focusing solar collectors  
[ASME PAPER 78-WA/SOL-4] 21 p0162 A79-19837
- Solar tracking control system Sun Chaser  
[NASA-TM-78199] 21 p0172 N79-10514
- TRADEOFFS**
- Thermal power systems small power systems applications project. Decision analysis for evaluating and ranking small solar thermal power system technologies. Volume 1: A brief introduction to multiattribute decision analysis --- explanation of multiattribute decision analysis methods used in evaluating alternatives for small powered systems  
[NASA-CR-158425] 22 p0368 N79-21548
- TRAFFIC CONTROL**
- Bus priority system studies  
22 p0299 A79-29339
- TRANSFORMERS**
- Symmetrical and asymmetrical ideal cylindrical radiation transformers and concentrators  
22 p0303 A79-29647
- TRANSIENT RESPONSE**
- Transient energy removal in cylindrical parabolic collector systems  
21 p0020 A79-10168
- Some aspects of the transient response of a flat-plate solar energy collector  
21 p0153 A79-18466
- Comparison of transient heat transfer models for flat plate collectors  
22 p0242 A79-21168
- Stability of work and sensitivity of semiconductor thermoelectric systems under automatic control  
22 p0261 A79-23624
- Transient response to three-phase faults on a wind turbine generator  
21 p0180 N79-11312
- TRANSITION FLOW**
- Effect of force field nonuniformity on flow in an MHD channel  
21 p0101 A79-16365
- TRANSITION METALS**
- Model predictions for the stability of ternary metallic hydrides  
21 p0038 A79-11802
- Methane production from carbon oxides over borohydride-reduced transition metals  
[PB-286385/0] 21 p0226 N79-15177
- TRANSITION TEMPERATURE**
- Screening reversible reactions for thermochemical energy transfer  
22 p0285 A79-26823
- TRANSMISSION EFFICIENCY**
- Design, construction and performance of Fresnel lens for solar energy collection  
21 p0136 A79-17456
- Effect of physical properties of a flat plate solar collector cover on efficiency calculations - Simplifying hypotheses  
21 p0164 A79-19949

## SUBJECT INDEX

## TRANSMISSION LINES

- 30-MJ superconducting magnetic energy storage /SMES/ unit for stabilizing an electric transmission system  
22 p0237 A79-20555
- 200-kv Blumlein transmission line for ultrafast toroidal theta-pinch  
22 p0297 A79-28917

## TRANSMISSION LOSS

- From sunlight in space to 60 Hz on earth - The losses along the way --- satellite solar power transmission efficiency  
21 p0003 A79-10027
- Electrical power loss from high-voltage power circuits through plasma leakage  
21 p0169 N79-10113

## TRANSMITTANCE

- An approximate equation for predicting the solar transmittance of transparent honeycombs  
21 p0042 A79-11877
- Direct solar transmittance for a clear sky --- for insolation of solar conversion systems  
22 p0296 A79-28361
- Performance characteristics of a 1.8 by 3.7 meter Fresnel lens solar concentrator  
[NASA-TM-78222] 22 p0360 N79-20495

## TRANSMUTATION

- Fuel technology and the environment --- nuclear reactor caused radiation effects and transmutation  
21 p0079 A79-14787

## TRANSPORT AIRCRAFT

- Laser aircraft propulsion  
21 p0109 A79-16618
- Fuel conservative aircraft engine technology  
21 p0164 A79-20078
- Very large vehicles - To be or --- aircraft design concepts  
22 p0306 A79-30484
- Large-vehicle concepts --- aircraft design  
22 p0306 A79-30485
- Energy conservation aircraft design and operational procedures  
21 p0202 N79-13200
- Energy efficient engine: Propulsion system-aircraft integration evaluation  
[NASA-CR-159488] 22 p0337 N79-16850
- An analysis of fuel conserving operational procedures and design modifications for bomber/transport aircraft. Volume 1: Executive summary  
[AD-A061746] 22 p0351 N79-18969
- An analysis of fuel conserving operational procedures and design modifications for bomber/transport aircraft, volume 2  
[AD-A062609] 22 p0356 N79-20109

## TRANSPORT PROPERTIES

- Migrational polarization in high-current density molten salt electrochemical devices  
21 p0039 A79-11811
- Partial processes and transport parameters in molten carbonate fuel cell operation  
21 p0040 A79-11819
- A practical electrochemical transport equation for non-dilute solutions --- for energy storage application  
21 p0041 A79-11841
- Role of the diode exponential factor in CdS solar cells  
21 p0123 A79-17348
- Transport phenomena in MHD generators - Effect of boundary layers  
21 p0156 A79-19098
- Radial transport in the ELMO Bumpy Torus in collisional regimes  
22 p0312 A79-31184

## TRANSPORT THEORY

- Alpha transport and blistering in tokamaks  
22 p0253 A79-22243
- Theory of anomalous transport due to electrostatic fluctuations --- low frequency plasma instabilities of drift wave type  
22 p0270 A79-24858
- Quasi-linear theory of heat flow and diffusion in a tokamak  
22 p0270 A79-24859

## TRANSPORT VEHICLES

- Optimal control of on-board and station flywheel storage for rail transit systems  
21 p0148 A79-17822



# SUBJECT INDEX

# TUBE HEAT EXCHANGERS

## TRANSPORTATION ENERGY

User experience with on-road electric vehicles in the U.S.A. and Canada 21 p0009 A79-10080

A critical review and evaluation of published electric-vehicle performance data 21 p0009 A79-10081

Pulse characteristics of sodium sulfur cells for electric vehicle propulsion 21 p0009 A79-10082

Evaluation of methods for analyzing silver-zinc cells 21 p0010 A79-10085

Review of industrial participation in the AVL lithium/iron sulfide battery development program --- for electric vehicles 21 p0010 A79-10086

High performance lithium/iron disulfide cells --- for electric vehicle propulsion 21 p0010 A79-10087

Lithium silicon - Iron sulfide load-leveling and electric vehicle batteries 21 p0010 A79-10088

Advances in the development of lithium-aluminum/metal sulfide cells for electric-vehicle batteries 21 p0010 A79-10089

Bipolar lithium/iron disulfide cells --- for electric vehicle propulsion 21 p0010 A79-10090

Mechanically rechargeable, metal-air batteries for automotive propulsion 21 p0011 A79-10093

Iron-air batteries for electric vehicles 21 p0011 A79-10094

Response of lead-acid batteries to chopper-controlled discharge --- for electric vehicles 21 p0011 A79-10097

Progress report on hydrogen production and utilization for community and automotive power 21 p0016 A79-10132

Energy efficiency in the transport sector 21 p0054 A79-13574

Vehicle operation on fuels from solar energy 21 p0059 A79-13663

Electric vehicles challenge battery technology 21 p0093 A79-15892

Energy requirements of the rail mode [ASME PAPER 78-HT-1] 21 p0150 A79-18085

Modeling energy and power requirements of electric vehicles 21 p0153 A79-18465

Rule of fuel management --- for airlines 21 p0155 A79-18521

Optimal control of on-board and station flywheel storage for rail transit systems [ASME PAPER 78-WA/DSC-32] 21 p0159 A79-19771

The sodium/sulfur battery - A storage battery for peak load adjustment and electric traction 21 p0165 A79-20244

Current status of composite flywheel development 22 p0241 A79-20853

Applications of metal hydrides --- emphasizing use as energy storage media 22 p0251 A79-21715

Evaluation of the effectiveness of electric power systems for transport purposes 22 p0284 A79-26723

Metropolitan work-trip energy consumption patterns 22 p0299 A79-29335

Application of kinetic energy storage to transportation systems --- flywheels 22 p0299 A79-29337

The influence of systems and operations on rapid rail energy utilization 22 p0299 A79-29338

International Conference on Electric Vehicle Development, London, England, May 31, June 1, 1977, Proceedings 22 p0300 A79-29487

Prospects for improvements in lead-acid batteries --- for electric vehicles 22 p0300 A79-29488

The energy and resource implications associated with the widespread use of electric vehicles 22 p0301 A79-29489

Recent developments in power sources with special emphasis on alkaline batteries --- for electric vehicles 22 p0301 A79-29490

The role of the battery electric vehicle 22 p0301 A79-29491

Support services for electric vehicles 22 p0301 A79-29492

Electric vehicles - Can they be fitted into urban Britain 22 p0301 A79-29493

Road vehicles with combined, at least partly electrical driving systems and energy supplies 22 p0301 A79-29494

The fleet operator's viewpoint --- on prototype electric bus development 22 p0302 A79-29495

Latest developments in sponsored test programs for electric vehicles in France 22 p0302 A79-29497

Electric car project of the Eindhoven University of Technology 22 p0302 A79-29498

An electric propulsion system for a town and city bus 22 p0302 A79-29499

The impact of aeronautical sciences on other modes of transport 22 p0325 A79-31915

Energy in transportation [PB-282928/1] 21 p0177 H79-10561

Transportation Energy Conservation Data Book, edition 2 [ORNL-5320] 21 p0184 H79-11487

Energy use in Japan and the United States [BNL-23101] 21 p0221 H79-14578

Environmental conservation concerns in transportation: Energy, noise, and air quality [PB-286550/9] 21 p0232 H79-15868

Fundamental combustion studies of emulsified fuels for diesel applications [PB-287386/7] 22 p0330 H79-16138

Liquefied natural gas safety research overview [AD-A063714] 22 p0365 H79-21233

Transportation energy conservation data book, edition 3 [ORNL-5493] 22 p0369 H79-21562

**TRAPPED PARTICLES**

Quasi-linear theory of heat flow and diffusion in a tokamak 22 p0270 A79-24859

**TROPICAL REGIONS**

Opportunities for direct use of geohat in Central America and other tropical countries 21 p0097 A79-16074

Solar radiation studies for utilization of flat-plate collectors in an equatorial region 21 p0119 A79-17311

**TROPOSPHERE**

Tropospheric conduits --- for pollution abatement and energy production 22 p0266 A79-24275

The natural and perturbed troposphere 21 p0179 H79-10636

**TRUCKS**

A high energy tubular battery for a 1800 kg payload electric delivery van [SAE PAPER 790162] 22 p0315 A79-31367

Utilization of waste heat in trucks for increased fuel economy [NASA-TN-79966] 21 p0215 H79-13937

**TRUSSS**

On-orbit fabrication and assembly of large space structural subsystems [IAF PAPER 78-192] 21 p0035 A79-11288

Wind turbine generator application places unique demands on tower design and materials 22 p0240 A79-20826

**TUBE CATHODES**

A high energy tubular battery for a 1800 kg payload electric delivery van [SAE PAPER 790162] 22 p0315 A79-31367

**TUBE HEAT EXCHANGERS**

Heat exchanger design for geothermal power plants 21 p0015 A79-10123

Optimising the pitching of tubes in a flat solar collector for increasing the efficiency for use in vapour absorption refrigeration 21 p0132 A79-17422

- Heat exchangers for Ocean Thermal Energy Conversion plants 21 p0142 A79-17506
- Analysis of energy storage by phase change with an array of cylindrical tubes 22 p0281 A79-26207
- Heat loss characteristics of an evacuated plate-in-tube collector 22 p0285 A79-26818
- Investigation of the heat transfer in cylindrical receiver configurations with inner tubes [ASME PAPER 79-GT-64] 22 p0306 A79-30532
- TUNGSTEN CARBIDES**
- Influence of composition on the activity of tungsten carbide gas diffusion hydrogen electrodes 22 p0245 A79-21482
- TURBIDITY**
- Dependence of solar radiation availability on atmospheric turbidity 21 p0119 A79-17308
- Differential insolation and turbidity measurements --- solar radiation attenuation by aerosols 22 p0241 A79-21056
- TURBINE BLADES**
- The influence of blade camber on the output of vertical-axis wind turbines 21 p0045 A79-12242
- Airfoil data for use of wind turbine designers 21 p0073 A79-14702
- Large filament wound structures for energy and transportation systems --- turbine blades for windpowered energy systems 21 p0086 A79-15507
- The design and testing of a vertical-axis wind turbine using sails 21 p0153 A79-18467
- Some effects of flow curvature on the performance of Darrieus wind turbines [AIAA PAPER 79-0112] 21 p0156 A79-19538
- Thermophoresis - Enhanced deposition rates in combustion turbine blade passages [ASME PAPER 78-WA/GT-1] 21 p0160 A79-19790
- An inverse problem of vertical-axis wind turbines 22 p0239 A79-20800
- Vortex sheet analysis of the Giromill --- vertical axis wind turbine with straight blades 22 p0278 A79-26179
- Evaluation of HOSTAS computer code for predicting dynamic loads in two-bladed wind turbines [AIAA 79-0733] 22 p0298 A79-29007
- A hybrid wind turbine suitable for developing regions 22 p0323 A79-31455
- Design, instrumentation, and calibration of a vertical axis wind turbine rotor [TID-27754] 21 p0174 A79-10533
- Structural performance of the DOE/Sandia 17 meter vertical axis wind turbine [SAND-78-0880C] 21 p0187 A79-11516
- Nonlinear dynamic response of wind turbine rotors [NASA-TN-78324] 21 p0195 A79-12542
- Giromill wind tunnel test and analysis, volume 2. Technical discussion [COO-2617-4/2] 21 p0204 A79-13378
- Evaluation of urethane for feasibility of use in wind turbine blade design [NASA-CR-159530] 22 p0360 A79-20497
- Evaluation of HOSTAS computer code for predicting dynamic loads in two bladed wind turbines [NASA-TN-79101] 22 p0368 A79-21549
- TURBINE ENGINES**
- Investigating combustion turbine burner performance with coal derived liquids having high fuel bound nitrogen [ASME PAPER 78-GT-126] 21 p0033 A79-10791
- Ceramic components for vehicular gas turbines 21 p0034 A79-11150
- Turbine engines in light aircraft 21 p0047 A79-12380
- Low head power generation with bulb turbines --- hydroelectric installations 21 p0074 A79-14705
- Program to establish ceramic technology readiness for large combustion turbine utility application [ASME PAPER 78-WA/GT-8] 21 p0160 A79-19796
- The interaction of the wind field with a horizontal axis wind turbine 22 p0278 A79-26177
- Wind power distribution, control, and conversion in vortex augmentors --- influence on turbomachinery design and development 22 p0278 A79-26180
- Some flow analyses for Tornado-type wind turbines 22 p0279 A79-26181
- High efficiency wave engine --- featuring rotor blade exit nozzle design for high efficiency 22 p0279 A79-26187
- Working fluids and turbines for OTEC power systems 22 p0280 A79-26192
- Operational characteristics of MHD turbine with air-core superconducting rotor 22 p0297 A79-28924
- High-freezing-point fuels used for aviation turbine engines [ASME PAPER 79-GT-141] 22 p0309 A79-30555
- Fluidized bed gas turbine experimental unit for MHD applications [ORNL/HD/BIUS-33] 21 p0221 A79-14575
- Cold-air performance of free power turbine designed for 112-kilowatt automotive gas-turbine engine. 2: Effects of variable stator-vane-chord setting angle on turbine performance [NASA-TN-78993] 22 p0345 A79-17859
- TURBINE EXHAUST NOZZLES**
- Demonstration of a rotary separator for two-phase brine and steam flows [TID-28519] 22 p0365 A79-21309
- TURBINE INSTRUMENTS**
- A minicomputer based data acquisition and analysis systems for vertical axis wind turbine testing 21 p0144 A79-17617
- TURBINE PUMPS**
- Hydropower from a national point of view --- projects for future energy production 21 p0059 A79-13656
- Cycle optimization for a solar turbopack --- turbine water pump utilizing Rankine cycle 21 p0141 A79-17500
- TURBINE WHEELS**
- Designing and testing Si3N4 turbine components at Mercedes-Benz 21 p0050 A79-12830
- Development of ceramic parts for a truck gas turbine at MTU 21 p0050 A79-12831
- Development of multi-density silicon nitride turbine rotors 21 p0050 A79-12832
- Analysis of wind turbine generator rotor response to one-dimensional turbulence 21 p0077 A79-14768
- Air bearing development for a GM automotive gas turbine [SAE PAPER 790107] 22 p0314 A79-31355
- TURBINES**
- Torque ripple in a vertical axis wind turbine 21 p0029 A79-10239
- Vortex sheet analysis of the Giromill 21 p0031 A79-10278
- Calculation of wake effects in wind turbine parks 21 p0045 A79-12241
- The influence of blade camber on the output of vertical-axis wind turbines 21 p0045 A79-12242
- Performance prediction methods for horizontal axis wind turbines 21 p0045 A79-12244
- The Netherlands experimental vertical axis wind turbine 21 p0114 A79-17120
- Fluid dynamics of diffuser-augmented wind turbines 22 p0238 A79-20798
- Cost-effectiveness of the vortex-augmented wind turbine 22 p0266 A79-24048
- Design, fabrication, and test of a composite material wind turbine rotor blade [NASA-CR-135389] 21 p0173 A79-10525
- Microprocessor control of a wind turbine generator [NASA-TN-79021] 21 p0195 A79-12548
- Lightning protection for the vertical axis wind turbine [SAND-77-1241] 21 p0221 A79-14567
- Evaluation of HOSTAS computer code for predicting dynamic loads in two bladed wind turbines [NASA-TN-79101] 22 p0368 A79-21549

# SUBJECT INDEX

# TURBOPROP ENGINES

## TURBOCOMPRESSORS

Technology evolution in the Allison Model 250 engine  
--- for helicopter propulsion

21 p0155 A79-18681

Storage peak gas-turbine power plant ---  
compressor for electric energy storage

22 p0268 A79-24507

High efficiency wave engine --- featuring rotor  
blade exit nozzle design for high efficiency

22 p0279 A79-26187

## TURBOFAN ENGINES

Advanced turbofan engines for low fuel consumption  
[ASME PAPER 78-GT-192]

21 p0033 A79-10816

Making turbofan engines more energy efficient  
[ASME PAPER 78-GT-198]

21 p0033 A79-10818

Engine technology for production turbofan engines

22 p0270 A79-24827

Energy efficient engine preliminary design and  
integration study

21 p0194 A79-12084

Energy efficient engine: Propulsion  
system-aircraft integration evaluation

22 p0337 A79-16850

## TURBOGENERATORS

The external combustion steam injected gas turbine  
for cogeneration

21 p0012 A79-10100

A proposed 40 MWe MHD pilot plant

21 p0017 A79-10137

JPL - Small Power Systems Applications Project ---  
for solar thermal power plant development and  
commercialization

21 p0019 A79-10161

Performance and economic risk evaluation of  
dispersed solar thermal power systems by Monte  
Carlo simulation

21 p0020 A79-10163

Heat pipe central solar receiver gas turbine plant

21 p0022 A79-10178

Power extracted from the wind

21 p0058 A79-13650

Solar thermal power systems point-focusing  
distributed receiver /PPDR/ technology - A  
project description

21 p0062 A79-13869

Optimum selection of a wind turbine generator system  
[AIAA PAPER 78-1774]

21 p0062 A79-13871

Low head power generation with bulb turbines ---  
hydroelectric installations

21 p0074 A79-14705

Large wind turbine generators --- NASA program  
status and potential costs

21 p0092 A79-15881

10-megawatt solar central receiver pilot plant

21 p0094 A79-15906

Layout and design characteristics of MHD power  
stations

21 p0105 A79-16481

Steam generator and turbomachines --- MHD power  
plant design and Soviet operational experience

21 p0106 A79-16489

Design of solar energy concentrators for power  
generation in residential and nonresidential areas

21 p0136 A79-17460

Exploitation of solar energy via modular power  
plants and multiple utilization of waste heat

21 p0141 A79-17497

Application of turbopack in solar energy systems

21 p0141 A79-17504

The theoretical analysis of an air turbine  
generation system --- for waterwave energy  
conversion

21 p0151 A79-18106

Structural design of a superheater for a central  
solar receiver

21 p0162 A79-19832

Gas turbine with waste heat utilization - Low  
investment costs and high fuel use efficiency

21 p0168 A79-20448

Background and system description of the Mod 1  
wind turbine generator

22 p0239 A79-20825

Wind turbine generator application places unique  
demands on tower design and materials

22 p0240 A79-20826

Fatigue impact on Mod-1 wind turbine design

22 p0240 A79-20827

Wind-turbine-generator rotor-blade concepts with  
low-cost potential

22 p0240 A79-20828

An operating 200 kW horizontal axis wind turbine

22 p0240 A79-20829

Microprocessor control of a wind turbine generator

22 p0244 A79-21302

Cost-effectiveness of the vortex-augmented wind  
turbine

22 p0266 A79-24048

The geothermal power station at Ahuachapan, El  
Salvador

22 p0266 A79-24239

Use of organic fluids in solar turbines

22 p0269 A79-24621

Thermodynamic basis for combining cycles of heat  
producing power plants

22 p0298 A79-29297

Ways of improving steam-gas power plants --- fuel  
economy

22 p0299 A79-29298

Energy statistics for large wind turbine arrays

22 p0299 A79-29371

NRC's wind energy program

22 p0319 A79-31426

Cylindrical parabolic collector optimization for  
interfacing with steam turbine generators

22 p0322 A79-31448

Design and application of large wind turbine  
generators

22 p0326 A79-31916

Off-shore multi-MW size wind turbine system  
development is the key to cost-effective wind  
energy for Sweden

22 p0326 A79-31917

Transient response to three-phase faults on a wind  
turbine generator

21 p0180 A79-11312

Solar thermal power systems program: Program  
summary

21 p0207 A79-13518

Combined cycle power generation. Citations from  
the NTIS data base

21 p0222 A79-14587

A 200-kW wind turbine generator conceptual design  
study

22 p0341 A79-17333

Methane utilization from coalbeds for power  
generation

22 p0352 A79-19171

Thermal power systems point-focusing distributed  
receiver technology project. Volume 1:  
Executive summary

22 p0360 A79-20492

TURBOJET ENGINES

Parametric performance of a turbojet engine  
combustor using jet A and A diesel fuel

22 p0357 A79-20114

TURBOMACHINE BLADES

A low cost blade design for a Darrieus-type  
vertical-axis wind turbine

21 p0067 A79-14291

TURBOMACHINE

Small solar power plant with a Freon turbine

21 p0057 A79-13642

The brake system for the DOE/Sandia 17-meter  
vertical axis wind turbine

21 p0067 A79-14289

Dynamic response of a wind turbine system and its  
effect on performance

21 p0067 A79-14293

Generalized wind characteristics and their effect  
on wind turbine output

21 p0068 A79-14294

Generic power performance estimates for wind  
turbines

21 p0068 A79-14295

Wind generation of electricity for a novel  
dwelling independent of servicing networks

21 p0142 A79-17513

Vertical axis wind turbine status

21 p0143 A79-17516

A Variable Speed Constant Frequency /VSCF/ wind  
generator for low power applications

22 p0303 A79-29799

TURBOPROP ENGINES

Modern engine development test techniques --- for  
helicopters

21 p0155 A79-18680

# TURBOSHAPTS

# SUBJECT INDEX

## TURBOSHAPTS

Modern engine development test techniques --- for helicopters 21 p0155 A79-18680

## TURBULENCE EFFECTS

On-line control of a large horizontal axis wind energy conversion system and its performance in a turbulent wind environment 21 p0028 A79-10236

Analysis of wind turbine generator rotor response to one-dimensional turbulence 21 p0077 A79-14768

## TURBULENT BOUNDARY LAYER

Insulating wall boundary layer in a Paraday MHD generator [PE-23417] 22 p0365 N79-21310

## TURBULENT FLOW

Preliminary results of a field experiment to characterize wind flow through a vertical plane [PNL-2518] 21 p0203 N79-13322

## TURBULENT WAKES

Energy effectiveness of arbitrary arrays of wind turbines [AIAA PAPER 79-0114] 21 p0156 A79-19540

## TURKEY

Investigations of solar heat production for household heating in Turkey 22 p0253 A79-22265

Calculation of solar energy incident on non-horizontal surfaces over Turkey 22 p0253 A79-22266

## TWO DIMENSIONAL FLOW

Solids mixing and fluidization characteristics in a tube filled bed --- of fluidized bed coal combustion 21 p0008 A79-10070

A two dimensional vortex sheet model of a Savonius Rotor 22 p0278 A79-26178

Vortex sheet analysis of the Giromill --- vertical axis wind turbine with straight blades 22 p0278 A79-26179

Two-dimensional MHD channel design --- for energy performance improvement at lower wall temperature 22 p0279 A79-26183

Two-dimensional analyses related to wave-energy extraction by submerged resonant ducts 22 p0312 A79-31099

Two-dimensional analysis of vertical axis windmills 22 p0353 N79-19446

## TWO FLUID MODELS

A collisional plasma rotating between two cylinders 21 p0049 A79-12694

## TWO PHASE FLOW

The role of interfacial heat and mechanical energy transfers in a liquid-metal MHD generator [ASME PAPER 78-WA/HT-33] 21 p0161 A79-19814

Experimental study of the characteristics of heat and mass transfer in a two-component low-temperature heat pipe 22 p0246 A79-21585

Modeling two-phase flow in a swirl combustor 22 p0280 A79-26189

Modeling the champagne effect in compressed air energy storage 22 p0280 A79-26190

# U

## U.S.S.R.

Pulsed-power research and development in the USSR [AD-A056635] 21 p0193 N79-11859

## ULTRASHORT PULSED LASERS

Performance of the short-pulse oscillators for Argus and Shiva 21 p0083 A79-15171

## ULTRAVIOLET RADIATION

The short-wavelength response of MIS solar cells 22 p0273 A79-25748

## UNDERGROUND STORAGE

Large-scale thermal energy storage for cogeneration and solar systems --- in aquifers 21 p0092 A79-15886

Underground aquifer storage of hot water from solar energy collectors 21 p0120 A79-17317

Earth-conducted heat losses from thermal storage systems 22 p0281 A79-26208

Studies on the effect of bed aspect ratios and pressure drop on flow distribution in rock bed storage systems for solar energy applications 22 p0317 A79-31409

Hydrogen energy storage program: Five-year plan [DOE/ET-0086] 21 p0175 N79-10544

## UNDERWATER COMMUNICATION

Recent terrestrial and undersea applications of radioisotope thermoelectric generators /RTGs/ 21 p0027 A79-10226

## UNITED STATES OF AMERICA

Long-term availability of water resources for energy development in the Central United States 21 p0065 A79-14118

Oil shale in the U.S. - Current state of technology and research 22 p0265 A79-23830

Prospects for solar heating and cooling in the United States 22 p0275 A79-25929

The Energy Research and Development Program of the United States 22 p0325 A79-31909

Energy: The new economic development wildcard [PE-282494/4] 21 p0177 N79-10564

Energy situation in the Mid-Atlantic region [BNL-50703] 21 p0188 N79-11528

Energy use in Japan and the United States [BNL-23101] 21 p0221 N79-14578

The national energy plan: Options under assumptions of national security threat or energy policy as if it really mattered [B-PRINT-95-42] 21 p0228 N79-15399

US energy demand and supply, 1976-1985: Limited options, unlimited constraints [B-PRINT-95-43] 21 p0228 N79-15400

United States civilian space programs: An overview [GPO-35-823] 21 p0232 N79-15815

Direction of gas supply research in the US 22 p0340 N79-17320

The good news about energy 22 p0355 N79-19461

## UNIVERSITY PROGRAM

MIT-DOE program to demonstrate an advanced superconducting generator 22 p0236 A79-20549

## URANIUM

Nonproliferation Alternative Systems Assessment Program (NASAP): Preliminary environmental assessment of thorium/uranium fuel cycle systems [ORNL/TN-6069] 21 p0192 N79-11570

Gaseous fuel reactors for power systems [LA-UR-78-1437] 21 p0214 N79-13844

GAO work involving title V of the Energy Policy and Conservation Act of 1975 [PB-286400/7] 21 p0230 N79-15424

Atlas of western surface-mined lands: Coal, uranium, and phosphate [PB-287846/0] 22 p0340 N79-17311

## URBAN DEVELOPMENT

Urbanism and energy in developing regions [LBI-7808] 21 p0189 N79-11540

## URBAN PLANNING

Prospects for ambient energy and cogeneration utilization in urban and regional planning 21 p0104 A79-16465

Conceptual development of a solar town in Iran 21 p0138 A79-17469

Planning program to accelerate energy conservation in municipalities [HCP/M05017-01/1] 21 p0210 N79-13536

Baltimore applications project [NASA-TN-79667] 22 p0351 N79-18815

## URBAN TRANSPORTATION

The propulsion of vehicles by a flywheel 21 p0031 A79-10452

Electric automobiles - Yes 21 p0046 A79-12265

Energy efficiency in the transport sector 21 p0054 A79-13574

Breakdown of rapid rail energy costs - A study of three systems 21 p0068 A79-14323

Total energy and labor requirements for an electric commuter railroad 21 p0068 A79-14325

Flywheels for vehicles --- auxiliary power in electric automobiles 21 p0092 A79-15885

## SUBJECT INDEX

## VACUUM SYSTEMS

- Metropolitan work-trip energy consumption patterns 22 p0299 A79-29335
- Bus priority system studies 22 p0299 A79-29339
- Electric vehicles - Can they be fitted into urban Britain 22 p0301 A79-29493
- An electric propulsion system for a town and city bus 22 p0302 A79-29499
- The London Electric Delivery Van Assessment Scheme [SAE PAPER 790111] 22 p0314 A79-31358
- Study of flywheel energy storage Volume 1: Executive summary [PB-282652/7] 21 p0176 A79-10555
- Study of flywheel energy storage. Volume 2: Systems analysis [PB-282653/5] 21 p0176 A79-10556
- Study of flywheel energy storage. Volume 3: System mechanization [PB-282654/3] 21 p0177 A79-10557
- Study of flywheel energy storage. Volume 4: Life-cycle costs [PB-282655/0] 21 p0177 A79-10558
- Study of flywheel energy storage. Volume 5: Vehicle tests [PB-282656/8] 21 p0177 A79-10559
- A study of flywheel energy storage for urban transit vehicles [PB-282929/9] 21 p0177 A79-10563
- Environmental conservation concerns in transportation: Energy, noise, and air quality [PB-286550/9] 21 p0232 A79-15868
- URETHANES**
- Evaluation of urethane for feasibility of use in wind turbine blade design [NASA-CR-159530] 22 p0360 A79-20497
- USER MANUALS (COMPUTER PROGRAMS)**
- Solar Irrigation Program Data Base Management System (SIPDBMS) [SAND-78-0641] 21 p0209 A79-13532
- Simulation of fluidized bed coal combustors [NASA-CR-159529] 22 p0359 A79-20487
- USER REQUIREMENTS**
- Current state-of-the-art of electrochemical batteries from a users point of view 21 p0071 A79-14681
- Development of specifications for recycled products 22 p0295 A79-28182
- The fleet operator's viewpoint --- on prototype electric bus development 22 p0302 A79-29495
- UTAH**
- A comparison of the silica and Na-K-Ca geothermometers for thermal springs in Utah 21 p0097 A79-16075
- Local perceptions of energy development: The case of the Kaiparowits Plateau [PB-287314/9] 22 p0335 A79-16380
- UTILITIES**
- High efficiency thermal energy storage system for utility applications 21 p0012 A79-10102
- Optimum design conditions for a power plant at a vapor dominated geothermal resource, Pacific Gas and Electric's The Geysers Power Plant Unit 16 21 p0014 A79-10121
- Perspectives on utility central station photovoltaic applications 21 p0041 A79-11873
- Pennies a day - Financing early deployment of photovoltaic utility applications through a user subsidy [AIAA PAPER 78-1767] 21 p0061 A79-13866
- Development of industrial owned, small hydroelectric facilities 21 p0073 A79-14699
- Modelling energy storage systems for electric utility applications Preliminary considerations 21 p0081 A79-14960
- Geothermal energy from a utility perspective --- Imperial Valley of Southern California 21 p0091 A79-15880
- Utility applications of wind power plants 21 p0092 A79-15882
- Solar heating and cooling - An electric utility perspective 21 p0093 A79-15890
- Storage as an energy strategy for utilities 21 p0093 A79-15891
- Role and status of dispersed electric utility fuel cell power plants 21 p0093 A79-15894
- The need for closed service areas in a supply economy based on line networks --- for German gas and electric utilities 21 p0168 A79-20447
- No ill winds for New Mexico utility --- windpower utilization in municipal electric power system 22 p0286 A79-27208
- Hydrogen - Potential key to tomorrow's energy utility 22 p0289 A79-27657
- Wind power and electric utilities - A review of the problems and prospects 22 p0300 A79-29374
- Photovoltaic electric power generation from a utility perspective [ASME PAPER 79-SOL-18] 22 p0309 A79-30552
- Development of sodium-sulfur batteries for utility application [EPRI-EM-683] 21 p0186 A79-11502
- Impact of electric passenger automobiles on utility system loads, 1985 - 2000 [EPRI-EA-623] 21 p0203 A79-13281
- Assessment of the solid waste impact of the National Energy Plan [BNL-50708] 21 p0213 A79-13572
- Current and projected fuel costs --- electric rate schedules and projected costs of fossil, synthetic, and nuclear fuels 21 p0218 A79-14532
- A detailed analysis of the impact of onsite equipment on utility costs --- marginal costs of providing backup power for solar energy systems 21 p0218 A79-14535
- Photovoltaic power systems for rural areas of developing countries [NASA-TN-79097] 21 p0229 A79-15411
- Assessment of the potential of solar thermal small power systems in small utilities [NASA-CR-158093] 22 p0335 A79-16377
- Utility operational experience on the NASA/DOE MOD-OA 200-kW wind turbine [NASA-TN-79084] 22 p0360 A79-20494
- Venture analysis case study for on-site fuel cell energy systems [FCR-0783-VOL-1] 22 p0361 A79-20505
- UTILITY AIRCRAFT**
- Environmental factors affecting the installation and operation of gas turbine engines in agricultural aircraft [SAE PAPER 781010] 22 p0274 A79-25892
- UTILIZATION**
- System for projecting the utilization of renewable resources. SPUR methodology [ERRQ/2322-77/4] 21 p0174 A79-10538
- V**
- VACUUM CHAMBERS**
- Integration of evacuated tubular solar collectors with lithium bromide absorption cooling systems 21 p0139 A79-17483
- Numerical computation of the loss coefficients for evacuated cylindrical collector receiver tubes [ASME PAPER 78-WA/SOL-3] 21 p0162 A79-19836
- VACUUM DEPOSITION**
- Stoichiometric Cu<sub>2</sub>S thin films for solar cells 21 p0123 A79-17349
- Gold, silver, chromium, and copper cermet selective surfaces for evacuated solar collectors 22 p0256 A79-22855
- VACUUM EFFECTS**
- Evacuated solar flat-plate collectors for economic applications 21 p0133 A79-17435
- VACUUM PUMPS**
- Problems in the use of cryogenic pumps in thermonuclear synthesis 22 p0305 A79-30264
- VACUUM SYSTEMS**
- A vacuum solar thermal collector with optimal concentration 21 p0043 A79-11970

## VACUUM TUBES

- Performance of vacuum tube solar collector systems
  - 21 p0102 A79-16424
- A two-dimensional thermal analysis of a new high-performance tubular solar collector
  - 22 p0352 N79-19060

## VALLEYS

- Application of LANDSAT data and digital image processing --- Ruhr Valley, Germany
  - [E79-10102] 22 p0339 N79-17291

## VALUE ENGINEERING

- Engineering handbook on the atmospheric environmental guidelines for use in wind turbine generator development
  - [NASA-TP-1359] 21 p0223 N79-14679

## VALVES

- Investigation of turbo-dyne energy chamber (G.R: valve trademark): An air bleed device
  - [PB-285381/0] 21 p0217 N79-14397

## VAPOR DEPOSITION

- Growth of refractory oxide layers by electrochemical vapor deposition /EVD/ at elevated temperatures --- for fuel cells
  - 21 p0039 A79-11812
- Chemical vapor deposited molybdenum films for use in photothermal conversion
  - 22 p0294 A79-28148
- Chemical vapor deposited amorphous silicon for use in photothermal conversion
  - 22 p0294 A79-28149

- Thin film battery/fuel cell power generating system
  - [CONS/1197-9] 22 p0369 N79-21556

## VAPOR JETS

- Design of a freon jet pump for use in a solar cooling system
  - [ASME PAPER 78-WA/SOL-15] 21 p0164 A79-19847

## VAPOR PRESSURE

- Liquid mixture excess volumes and total vapor pressures using a magnetic suspension densimeter with compositions determined by chromatographic analysis Methane plus ethane
  - 21 p0085 A79-15324

## VAPORIZING

- Suppression of vaporization in copper-silver-selenide thermoelectric materials
  - 21 p0027 A79-10224
- Liquid-phase reactions of vaporizing hydrocarbon fuels
  - 21 p0052 A79-12987

## VARIABLE GEOMETRY STRUCTURES

- Development of gas turbine performance seeking logic
  - [ASME PAPER 78-GT-13] 21 p0031 A79-10257

## VEGETATION

- Atlas of western surface-mined lands: Coal, uranium, and phosphate
  - [PB-287846/0] 22 p0340 N79-17311

## VELOCITY DISTRIBUTION

- A comparison of the Weibull and Rayleigh distributions for estimating wind power potential
  - 21 p0045 A79-12243
- An analytical expression for the specific output of wind turbine generators
  - 22 p0273 A79-25720
- Velocity, temperature, and electrical conductivity profiles in hydrogen-oxygen MHD duct flows
  - 22 p0279 A79-26184
- Energy statistics for large wind turbine arrays
  - 22 p0299 A79-29371

## VELOCITY MEASUREMENT

- Measurements of plasma rotation in tokamak LT-3
  - 22 p0252 A79-22238
- Oahu wind power survey
  - [PB-287361/0] 22 p0335 N79-16382

## VENTILATION

- Heat recovery devices for building HVAC systems --- Heating Ventilating and Air Conditioning
  - 21 p0073 A79-14697
- Boosting the performance of solar HVAC systems by improving component interactions --- Heating, Ventilating and Air Conditioning
  - 21 p0089 A79-15851
- Using controls to reduce component size and energy needs for solar HVAC --- Heating Ventilation, Air Conditioning
  - 21 p0102 A79-16421
- Solar heating and ventilating by natural means
  - 21 p0103 A79-16458

- Solar heating and ventilation using the modified Trombe wall system
  - 22 p0320 A79-31435

## VENTURI TUBES

- Effect of swirler-mounted mixing venturi on emissions of flame-tube combustor using jet A fuel
  - [NASA-TP-1393] 21 p0215 N79-14099

## VIBRATION MODE

- Spatial oscillations of a solid body carrying a low-power flywheel motor --- dual spin spacecraft motion control
  - 21 p0148 A79-17792

## VISCOSITY

- Viscosity stabilized solar ponds
  - 21 p0133 A79-17430

## VOLATILITY

- Shock tube studies of coal devolatilization
  - 21 p0083 A79-15247

## VOLCANOES

- Toward assessing the geothermal potential of the Jemez Mountains volcanic complex: A telluric-magnetotelluric survey
  - [LA-7656-MS] 22 p0358 N79-20458

## VOLT-AMPERE CHARACTERISTICS

- Factors affecting the open-circuit voltage and electrode kinetics of some iron/titanium/redox flow cells
  - 21 p0040 A79-11824

- Role of the diode exponential factor in CdS solar cells
  - 21 p0123 A79-17348

- Stoichiometric Cu<sub>2</sub>S thin films for solar cells
  - 21 p0123 A79-17349

- Response of p-n junction solar cells to concentrated sunlight and partial illumination
  - 21 p0124 A79-17353

- Grain-boundary edge passivation of GaAs films by selective anodization --- shorting effect in solar cells
  - 21 p0154 A79-18487

- A high-efficiency GaAs double-heterostructure photovoltaic detector --- with antireflection coating
  - 21 p0154 A79-18489

- On the role of interface states in MOS solar cells
  - 21 p0156 A79-19092

- A two-junction cascade solar-cell structure
  - 22 p0256 A79-22856

- A better approach to the evaluation of the series resistance of solar cells
  - 22 p0281 A79-26242

- The effect of the dispersion of the characteristics of solar cells in large systems
  - 22 p0285 A79-26822

- Discharge characteristics of a soluble iron-titanium battery system
  - 22 p0286 A79-26996

- An investigation of dark current and photocurrent superposition in photovoltaic devices
  - 22 p0291 A79-27871

- Application of the superposition principle to solar-cell analysis
  - 22 p0300 A79-29426

- Effects of minority-carrier storage at the interface states on the fill factor of m.i.s. solar cells
  - 22 p0313 A79-31347

## VOLTAGE CONVERTERS (DC TO DC)

- Contribution to the development of wind energy systems using static power electronic converters
  - 22 p0286 A79-26958

## VORTEX GENERATORS

- Subsonic diffusers for MHD generators
  - 22 p0279 A79-26185

## VORTEX SHEETS

- Vortex sheet analysis of the Gironmill
  - 21 p0031 A79-10278

- A two dimensional vortex sheet model of a Savonius Rotor
  - 22 p0278 A79-26178

- Vortex sheet analysis of the Gironmill --- vertical axis wind turbine with straight blades
  - 22 p0278 A79-26179

## VORTICES

- Cost-effectiveness of the vortex-augmented wind turbine
  - 22 p0266 A79-24048

# SUBJECT INDEX

# WASTE ENERGY UTILIZATION

Wind power distribution, control, and conversion  
in vortex augmentors --- influence on  
turbomachinery design and development 22 p0278 A79-26180

Wind power from a vortex chamber 22 p0319 A79-31425

## W

### WAFERS

Pilot line report: Development of a high  
efficiency thin silicon solar cell  
[NASA-CR-158028] 21 p0219 A79-14548

Evaluation of the technical feasibility and  
effective cost of various wafer thicknesses for  
the manufacture of solar cells  
[NASA-CR-158095] 22 p0334 A79-16368

### WAKES

Calculation of wake effects in wind turbine parks 21 p0045 A79-12241

Wind turbine generator wakes  
[AIAA PAPER 79-0113] 21 p0156 A79-19539

### WALL TEMPERATURE

Two-dimensional MHD channel design --- for energy  
performance improvement at lower wall temperature 22 p0279 A79-26183

Three-dimensional effects of electrode  
configuration on diagonal MHD generator  
performance 22 p0283 A79-26523

The effects of wall temperature on light  
impurities in Alcator --- tokamak device 22 p0313 A79-31188

### WALLS

Solar heating and ventilation using the modified  
Trombe wall system 22 p0320 A79-31435

South wall solar collector with active collector  
system 22 p0320 A79-31436

Insulating wall boundary layer in a Faraday MHD  
generator [PE-23417] 22 p0365 A79-21310

### WARPAGE

Mechanical deflection analysis of diamond turned  
reflective optics --- for laser fusion 21 p0083 A79-15143

### WASTE DISPOSAL

Disposal of industrial wastes by combustion:  
Present state-of-the-art. Volume 3 --- Book 21 p0036 A79-11675

Stabilization of power plant scrubbing slurries  
and fine coal refuse with the additive Calcilox 21 p0063 A79-14107

Evaluation of the Ames, Iowa refuse derived fuel  
recovery system 21 p0064 A79-14115

Environmental effects of burning solid waste as fuel 21 p0082 A79-15115

Solid waste and coal firing in industrial boilers 21 p0096 A79-15918

Co-disposal of sewage sludge using refuse-derived  
fuel 21 p0097 A79-16098

Solid waste and biomass. Their potential as  
energy sources in Illinois, 1977 [PB-281649/4] 21 p0177 A79-10562

Energy use patterns for metal recycling [PB-284855/4] 21 p0201 A79-13152

Assessment of the solid waste impact of the  
National Energy Plan [BRL-50708] 21 p0213 A79-13572

A methodology for evaluating the potential  
materials and energy recovery from municipal  
solid waste 21 p0215 A79-13935

Engineering and economic analysis of waste to  
energy systems [PB-285797/1] 21 p0224 A79-14946

Stimulated biodegradation of waste petroleum 22 p0336 A79-16388

Preliminary environmental assessment of biomass  
conversion to synthetic fuels [PB-289775/9] 22 p0365 A79-21224

An assessment of subsurface salt water disposal  
experience on the Texas and Louisiana Gulf coast  
for application to disposal of salt water from  
geopressed geothermal wells [BVO/1531-2] 22 p0366 A79-21523

Pollution control guidelines for coal refuse piles  
and slurry ponds [PB-291369/7] 22 p0373 A79-21682

**WASTE ENERGY UTILIZATION**

Thermal energy storage for industrial waste heat  
recovery 21 p0012 A79-10101

The Department of Energy's thermionic energy  
conversion program 21 p0025 A79-10213

The utilization of European space techniques for  
energy production [IAP PAPER 78-190] 21 p0035 A79-11287

Low-grade thermal energy-conversion Joule effect  
heat engines [ASME PAPER 78-ENAS-7] 21 p0048 A79-12556

Ceramic heat exchanger - Applications and  
developments 21 p0050 A79-12826

Dispersed power systems and total energy --- solar  
energy conversion for combined  
mechanical/electrical and thermal loads [AIAA PAPER 78-1770] 21 p0062 A79-13868

State-of-the-art assessment of air pollution  
control technologies for various waste-as-fuel  
processes 21 p0064 A79-14111

Evaluation of the Ames, Iowa refuse derived fuel  
recovery system 21 p0064 A79-14115

Heat recovery devices for building HVAC systems  
--- Heating Ventilating and Air Conditioning 21 p0073 A79-14697

Solar total energy systems 21 p0090 A79-15863

Large-scale thermal energy storage for  
cogeneration and solar systems --- in aquifers 21 p0092 A79-15886

Increasing the efficiency of coal-fired steam  
electric plants with thermionic topping 21 p0096 A79-15921

Inexpensive solar energy utilization in human  
settlements 21 p0104 A79-16470

The feasibility of constructing a photoelectric  
unit utilizing effluent heat 21 p0125 A79-17358

Exploitation of solar energy via modular power  
plants and multiple utilization of waste heat 21 p0141 A79-17497

The Koppelman process --- to upgrade lignite and  
some waste energy sources 21 p0145 A79-17634

The Stirling engine, an energy converter for  
cogeneration applications [ASME PAPER 78-WA/ENER-4] 21 p0159 A79-19777

Gas turbine with waste heat utilization - Low  
investment costs and high fuel use efficiency 21 p0168 A79-20448

Substitute natural gas from coal using  
high-temperature reactor heat - Project  
'Prototype Plant Nuclear Process Heat' 22 p0264 A79-23827

Gasification of coal with high-temperature reactor  
heat - Investigations concerning the market and  
the economics 22 p0264 A79-23828

Industrial cogeneration - Problems and promise ---  
waste heat utilization from electricity production 22 p0265 A79-24047

Medium-power /100-1000 kWe/ solar power plants  
using distributed collectors 22 p0269 A79-24622

Feasibility of MHD-ac induction electric power plant  
--- using tokamak reactor exhaust plasma 22 p0303 A79-29794

An evaluation of wood-waste energy conversion  
systems 21 p0174 A79-10528

Applications of thermal energy storage to process  
heat and waste heat recovery in the iron and  
steel industry [NASA-CR-159397] 21 p0183 A79-11473

Thermal storage for industrial process and reject  
heat [NASA-TN-78994] 21 p0183 A79-11481

Utilization of waste heat in trucks for increased  
fuel economy [NASA-TN-79966] 21 p0215 A79-13937

## WASTE UTILIZATION

- Engineering and economic analysis of waste to energy systems  
[PB-285797/7] 21 p0224 879-14946
- Energy and economic analysis of industrial process heat recovery with heat pumps 22 p0331 879-16210
- Methane utilization from coalbeds for power generation  
[TID-28408] 22 p0352 879-19171
- MDH balance of plant technology project  
[ANL-MHD-78-7] 22 p0361 879-20500
- Test procedures for the determination of the gross calorific value of refuse and refuse-derived-fuels by oxygen bomb calorimetry: Summary of the 1977 fiscal year results 22 p0364 879-21167
- The role of thermal energy storage in industrial energy conservation  
[NASA-TN-79122] 22 p0368 879-21550
- WASTE UTILIZATION**
- New processes for the recovery of resource materials from coal combustion wastes 21 p0007 879-10065
- Fluidized-bed combustion of low-quality fuels 21 p0007 879-10066
- The need for materials recycling 21 p0047 879-12340
- Potential agricultural uses of fluidized bed combustion waste 21 p0064 879-14108
- Forest residues as an alternate energy source 21 p0072 879-14689
- Steam raising with low-Btu gas generators and potential for other applications 21 p0072 879-14690
- Source emissions factors for refuse derived fuels 21 p0082 879-15084
- Biomass and wastes as energy resources - 1977 update 21 p0091 879-15868
- New concepts in waste utilization and biomass 21 p0095 879-15915
- Industrial wastes to energy 21 p0096 879-15916
- Energy from urban waste 21 p0096 879-15917
- Advanced processes for more efficient use of forest products residual material 21 p0096 879-15919
- Co-disposal of sewage sludge using refuse-derived fuel 21 p0097 879-16098
- Energy conservation by means of recycling 21 p0112 879-16735
- Urban wastes as an energy source 21 p0115 879-17220
- Operation and emission of a stoker-fired boiler while burning refuse derived fuel and coal mixtures  
[ASME PAPER 78-WA/APC-2] 21 p0158 879-19735
- Corrosion and deposits from combustion of solid waste. VI - Processed refuse as a supplementary fuel in a stoker-fired boiler  
[ASME PAPER 78-WA/FU-4] 21 p0160 879-19788
- Weak points of our prediction models for raw materials strategy --- waste materials and scrap recycling 22 p0265 879-24040
- Development of specifications for recycled products 22 p0295 879-28182
- Modern technology for recovering energy and materials from urban wastes - Its applicability in developing countries 22 p0295 879-28183
- Utilisation of solid waste 22 p0304 879-30204
- Sensible heat storage for solar energy applications 22 p0322 879-31449
- Conversion of biomass materials into gaseous products, phase 1  
[SAN/1241-77/1] 21 p0171 879-10237
- Methane generation from human, animal, and agricultural wastes  
[PB-276469/4] 21 p0171 879-10240
- Net energy analysis of five energy systems  
[ORAU/IEA(R)-77-12] 21 p0174 879-10534
- Preliminary environmental assessment of energy conversion processes for agricultural and forest product residues, volume 1  
[PB-281189/1] 21 p0178 879-10574

## SUBJECT INDEX

- Methanol from wood waste: A technical and economic study  
[FPL-12] 21 p0194 879-12239
- Antimony, arsenic, and mercury in the combustible fraction of municipal solid waste  
[PB-285196/2] 21 p0213 879-13590
- The anaerobic attached film expanded bed reactor for the treatment of dilute organic wastes 22 p0356 879-19928
- WATER**
- A copper oxide-copper sulfate water-splitting cycle 21 p0015 879-10128
- Iron oxide semiconductor electrodes in photoassisted electrolysis of water 21 p0037 879-11781
- Study of the interaction of H<sub>2</sub>O and O<sub>2</sub> with the surface of TiO<sub>2</sub> by electron stimulated desorption and Auger and characteristic loss spectroscopies 21 p0037 879-11793
- Hydrogen production by conventional and modified water electrolysis 21 p0059 879-13659
- Solar pumping --- thermal and electrical water pumping 21 p0104 879-16469
- Solar ammonia-water absorption system for cold storage application 21 p0143 879-17521
- The thermochemical decomposition of water using bromine and iodine 22 p0238 879-20770
- Problems around Fe-Cl cycles --- thermochemical decomposition of water hydrogen production 22 p0238 879-20771
- Sulfuric acid-water - Chemical heat pump/energy storage system demonstration 22 p0281 879-26209
- Coal gasification studies. I - Single stage complete gasification of coal using water as the hydrogen source 22 p0283 879-26466
- A flat plate multiple pass solar collector using aqueous optical properties 22 p0293 879-28144
- Water-cooled gas turbine technology development - Fuels flexibility  
[ASME PAPER 79-GT-72] 22 p0307 879-30536
- Thermochemical production of hydrogen from water  
[LA-UR-78-652] 21 p0180 879-11236
- Solar photolysis of water  
[NASA-CASE-NPO-14126-1] 21 p0182 879-11470
- The emissions and fuel economy of a Detroit diesel 6-71 engine burning a 10-percent water-in-fuel emulsion  
[AD-A058550] 21 p0203 879-13375
- Environmental and radiological safety studies. Interaction of (Pu-238)O<sub>2</sub> heat sources with terrestrial and aquatic environments --- soil and water analysis  
[LA-7033-PR] 21 p0232 879-15783
- Proceedings of symposium on water-in-fuel emulsions in combustion --- marine diesels, boilers, and gas turbine engines  
[AD-A061503] 22 p0338 879-17019
- Solar water pumps. Citations from the Engineering Index data base  
[NTIS/PS-78/1288/6] 22 p0343 879-17348
- WATER CIRCULATION**
- An analytical and experimental study of pumped solar water heaters 21 p0128 879-17389
- WATER CONSUMPTION**
- Water-related environmental effects in fuel conversion. Volume 2: Appendices  
[PB-288874/1] 22 p0356 879-19496
- WATER FLOW**
- Assessment of the potential of generating power from aqueous saline solutions by means of Osmo-Hydro Power systems 21 p0016 879-10133
- Thermosyphon solar water heating system under Brazilian conditions 21 p0021 879-10177
- Wave driven power generating system 21 p0059 879-13657
- Experiments with a flat plate solar water heating system in thermosyphonic flow 22 p0262 879-23755



# SUBJECT INDEX

# WATER TEMPERATURE

## WATER HEATING

- Thermosyphon solar water heating system under Brazilian conditions 21 p0021 A79-10177
  - Asymptotic behaviour as a guide to the long term performance of solar water heating systems 21 p0041 A79-11872
  - Alternative energy for domestic hot water - Wind or solar 21 p0067 A79-14292
  - The analysis by stochastic modelling of solar systems for space and water heating 21 p0137 A79-17466
  - Dynamic response of a novel solar water heater --- collector using low-boiling liquid between flat plates 21 p0140 A79-17488
  - Heat transfer analysis of flat plate type domestic solar water heater 21 p0140 A79-17489
  - Experiments with a flat plate solar water heating system in thermosyphonic flow 22 p0262 A79-23755
  - Effects of low solar input and amount of storage on thermosyphon hot water system performance 22 p0267 A79-24312
  - Solar energy for industrial process steam 22 p0267 A79-24315
  - Current status and prospects for low-temperature solar energy 22 p0269 A79-24623
  - Solar heating, cooling and hot water production - A critical look at CCHS installations 22 p0275 A79-25931
  - Design considerations for residential solar heating and cooling systems utilizing evacuated tube solar collectors 22 p0285 A79-26815
  - The Tritherm test house --- solar heating experiment 22 p0290 A79-27723
  - Economic feasibility of solar water and space heating 22 p0292 A79-27899
  - A Markov model of solar energy space and hot water heating systems 22 p0295 A79-28353
  - Production and application of rolling-welded aluminum alloy panels for solar water heaters for hot water and cooling systems 22 p0297 A79-28670
  - Study of the temperature distribution across the width of the screen of low-temperature water heaters with tubular heat receivers 22 p0297 A79-28671
  - Case history - Hybrid passive/active solar system: Performance and cost 22 p0313 A79-31315
  - Measured and predicted performance of solar domestic water heaters 22 p0319 A79-31422
  - Domestic water preheating using solar energy 22 p0321 A79-31437
  - Economic design of a solar domestic water heating system 22 p0321 A79-31438
  - Control system for solar hot water system 22 p0321 A79-31442
  - Solutions to energy conservation in northern climates 22 p0321 A79-31443
  - Solar heating of domestic hot water at the Confederation Heights Cafeteria 22 p0323 A79-31457
  - P.E.I. solar assisted domestic water heat project 22 p0323 A79-31458
  - Certification report for the CALBAC solar powered pump [NASA-CR-150872] 22 p0341 A79-17331
- ## WATER MANAGEMENT
- Optimal decisions for long-term operation of hydropower systems 22 p0245 A79-21473
  - Remote sensing use in hydraulic planification in Mexico 22 p0255 A79-22522
  - Water/energy management and evaluation model for Pennsylvania [PB-287577/1] 22 p0343 A79-17353

## WATER POLLUTION

- Environmental impacts of industrial energy systems in the coastal zone 21 p0075 A79-14722
  - Coupled heat and organic wastes stream pollution 21 p0086 A79-15602
  - OTEC program status and plans 21 p0094 A79-15902
  - Mercury in some New Zealand geothermal discharges 22 p0257 A79-22925
  - Factors affecting bitumen recovery by the hot water process 22 p0282 A79-26463
  - Source assessment: Water pollutants from coal storage areas [PB-285420/6] 21 p0223 A79-14635
  - Oil pollution reports, volume 5, number 2 --- bibliographies [PB-287071/5] 22 p0336 A79-16437
  - Applying NASA remote sensing data to geologically related regional planning problems in Tennessee [E79-10095] 22 p0339 A79-17289
  - Environmental assessment of the Alaskan Continental Shelf. Volume 1: Biological studies [PB-289154/7] 22 p0344 A79-17366
  - Environmental assessment of the Alaskan Continental Shelf. Volume 2: Biological studies [PB-289155/4] 22 p0344 A79-17367
  - Environmental assessment of the Alaskan Continental Shelf. Volume 3: Biological studies [PB-289156/2] 22 p0344 A79-17368
  - Marine biological effects of OCS petroleum development [PB-288935/0] 22 p0344 A79-17374
  - Treatment of petroleum refinery, petrochemical and combined industrial-municipal wastewaters with activated carbon: Literature review [PB-288211/6] 22 p0350 A79-18497
  - Water-related environmental effects in fuel conversion, volume 1. Summary [PB-288313/0] 22 p0351 A79-18834
  - Environmental assessment: Source test and evaluation report, Chapman low-Btu gasification [PB-289940/9] 22 p0373 A79-21662
- ## WATER PRESSURE
- Combustion of hydrothermally treated coals [PB-287521/9] 22 p0338 A79-17025
- ## WATER RESOURCES
- New energy from an old source - Hydrogen from falling water 21 p0015 A79-10129
  - Sea water desalination by means of solar energy 21 p0057 A79-13645
  - Long-term availability of water resources for energy development in the Central United States 21 p0065 A79-14118
  - Power from glaciers - The hydropower potential of Greenland's glacial water 21 p0087 A79-15672
  - Regional analysis of potential water power 21 p0148 A79-17825
  - Solar energy, water, and industrial systems in arid lands: Technological overview and annotated bibliography [PB-285129/3] 21 p0211 A79-13549
  - Water related constraints in energy production [PB-285713/4] 21 p0222 A79-14582
  - The ground water and energy supply situation for Great Plains irrigation [PB-296002/1] 21 p0222 A79-14586
  - The impact of energy resource development on water resource allocations [PB-286135/9] 21 p0231 A79-15432
  - Applying NASA remote sensing data to geologically related regional planning problems in Tennessee [E79-10095] 22 p0339 A79-17289
  - Resource analysis: Water and energy as linked resources [PB-288046/6] 22 p0349 A79-18463
- ## WATER TEMPERATURE
- Hybrid air to water solar collector design 21 p0021 A79-10174
  - Central solar heat stations and the Studsvik Demonstration Plant 21 p0021 A79-10175
  - A low cost approach to performance monitoring for the evaluation of a solar domestic hot water system 21 p0088 A79-15842

# WATER TREATMENT

# SUBJECT INDEX

A comparison of the silica and Na-K-Ca geothermometers for thermal springs in Utah  
21 p0097 A79-16075

Controls for heat reclaim with thermal storage coupled with solar heating  
21 p0102 A79-16420

Economic use of materials in the design of solar water-heating collector plates of the pipe and fin type  
21 p0129 A79-17396

Comparative performance testing of flat-plate solar water heaters  
21 p0130 A79-17405

Thermal performance testing of flat-plate solar collectors  
21 p0130 A79-17407

Testing of water-heating collectors according to ASHRAE Standard 93-77  
21 p0130 A79-17410

Geothermal power and water production studies at the University of California  
[ASME PAPER 78-WA/ENER-7]  
21 p0159 A79-19778

Solar water heaters for a cold climate  
22 p0254 A79-22325

Largo hot water system long range thermal performance test report, addendum  
[NASA-CR-150842]  
21 p0204 A79-13492

Prototype solar-heated hot water systems and double-walled heat exchangers  
[NASA-CR-150854]  
21 p0205 A79-13495

Prototype solar heating and cooling systems including potable hot water  
[NASA-CR-150850]  
21 p0205 A79-13498

LARGO hot water system thermal performance test report  
[NASA-CR-150841]  
21 p0205 A79-13500

Design and installation package for solar hot water system  
[NASA-CR-150859]  
21 p0220 A79-14556

Solar hot water system installed at Anderson, South Carolina  
[NASA-CR-150856]  
21 p0229 A79-15405

Solar heating and hot water system installed at Listerhill, Alabama  
[NASA-CR-150870]  
21 p0229 A79-15406

**WATER TREATMENT**  
There is a lot of energy in digester gas . . . use it --- in municipal waste water plants  
21 p0035 A79-11448

A new thermochemical process for hydrogen production  
22 p0312 A79-31153

Direct thermomagnetic splitting of water  
22 p0312 A79-31154

Total energy consumption for municipal wastewater treatment  
[PB-286688/7]  
21 p0231 A79-15439

Resource analysis: Water and energy as linked resources  
[PB-288046/6]  
22 p0349 A79-18463

**WATER WAVES**  
Two-dimensional analyses related to wave-energy extraction by submerged resonant ducts  
22 p0312 A79-31099

**WATERWAVE ENERGY CONVERSION**  
Wave energy conversion in a random sea  
21 p0030 A79-10252

Wave driven power generating system  
21 p0059 A79-13657

Wind, waves, and tides --- as future energy sources  
21 p0074 A79-14719

Useful power from ocean waves  
21 p0077 A79-14773

Ocean energy unlimited --- water wave conversion  
21 p0095 A79-15908

International Symposium on Wave and Tidal Energy, University of Kent, Canterbury, England, September 27-29, 1978, Proceedings. Volume 1  
21 p0150 A79-18101

A theory for wave-power absorption by two independently oscillating bodies  
21 p0151 A79-18103

The theoretical analysis of an air turbine generation system --- for waterwave energy conversion  
21 p0151 A79-18106

Wave power electric generation study in Japan --- large scale buoy facility  
21 p0151 A79-18107

The use of wave powered systems for desalination - A new opportunity --- seawater pumping for reverse osmosis  
21 p0151 A79-18108

Principles of design and construction for marine structures for wave/tidal/ocean thermal energy  
21 p0152 A79-18114

Integrating wave power into the electricity supply system  
21 p0152 A79-18117

The oscillating water column wave-energy device  
22 p0252 A79-22223

Wave-tank experiments on an immersed parallel-plate duct --- for testing performance of sub-sea wave energy converter  
22 p0258 A79-23306

A theory for wave-power absorption by two independently oscillating bodies  
22 p0259 A79-23307

On the dynamics of wave-power devices  
22 p0269 A79-24539

A wave activated electric generator --- waterwave energy conversion  
22 p0288 A79-27389

Energy from sea waves - System optimization by diffraction theory  
22 p0288 A79-27390

**WATERWAVE POWERED MACHINES**  
A wave power machine using free floating vertical plates  
21 p0151 A79-18104

Experiences with a hydropneumatic wave power device  
21 p0151 A79-18105

**WAVE DIFFRACTION**  
Energy from sea waves - System optimization by diffraction theory  
22 p0288 A79-27390

**WAVE DISPERSION**  
Cyclotron-wave spectrum in a plasma with two ion species  
22 p0245 A79-21443

The contribution of plasma dielectric properties to the cyclotron radiation spectrum from a tokamak plasma  
22 p0312 A79-31183

A ray-tracing analysis of fast-wave heating of tokamaks  
22 p0313 A79-31186

**WAVE INTERACTION**  
Wave-tank experiments on an immersed parallel-plate duct --- for testing performance of sub-sea wave energy converter  
22 p0258 A79-23306

**WAVE REFLECTION**  
Wave reflection from the lower hybrid surface - A toroidal effect --- in tokamaks  
22 p0255 A79-22427

Effects of nonlinear decay of backscattered light on the anomalous reflectivity --- in laser plasmas  
22 p0310 A79-30742

**WEATHERING**  
Long-term weathering effects on the thermal performance of the Lennox/Honeywell (liquid) solar collector  
[NASA-CR-150818]  
21 p0204 A79-13493

Environmental and radiological safety studies. Interaction of (Pu-238)O2 heat sources with terrestrial and aquatic environments --- soil and water analysis  
[LA-7033-PR]  
21 p0232 A79-15783

Long term weathering effects on the thermal performance of the sunworks (liquid) solar collector  
[NASA-CR-150899]  
22 p0341 A79-17328

Long-term weathering effects on the thermal performance of the Libbey-Owens-Ford (liquid) solar collector  
[NASA-CR-161093]  
22 p0348 A79-18450

Long term weathering effects on the thermal performance of the solaron (air) solar collector  
[NASA-CR-161166]  
22 p0371 A79-21621

**WEATHERPROOFING**  
Energy conservation and the rural home: Economic considerations for the nation and the individual  
[PB-286222/5]  
21 p0230 A79-15425

**WEDGES**  
Verification of wedge concentration using a helium neon laser --- solar collector design  
21 p0098 A79-16104

## SUBJECT INDEX

## WINDMILLS (WINDPOWERED MACHINES)

## WEIBULL DENSITY FUNCTIONS

- A comparison of the Weibull and Rayleigh distributions for estimating wind power potential  
21 p0045 A79-12243
- Frequency distribution of wind speed near the surface  
21 p0165 A79-20139

## WEIGHT (MASS)

- Development of advanced fuel cell system  
[NASA-CR-159443] 21 p0196 A79-12553

## WEIGHT ANALYSIS

- Vehicle Design Evaluation Program (VDEP). A computer program for weight sizing, economic, performance and mission analysis of fuel-conservative aircraft, multibodied aircraft and large cargo aircraft using both JP and alternative fuels  
[NASA-CR-145070] 21 p0200 A79-13026

## WEIGHT REDUCTION

- Silver-hydrogen, a long life light weight energy storage system --- design for spacecraft  
21 p0001 A79-10012
- Design features of the TDRSS solar array --- Tracking and Data Relay Satellites  
21 p0002 A79-10019
- Large, lightweight, replicated mirrors  
21 p0043 A79-11976
- Ultralightweight structures for space power --- solar energy collection for transmission to earth  
21 p0108 A79-16609
- Optimal distribution of heat conducting material in the finned pipe solar energy collector  
22 p0242 A79-21163

## WELLS

- Study of acoustic and microseismic emissions associated with a hydraulic fracture --- geothermal energy utilization  
21 p0076 A79-14744

## WILDLIFE

- A biologist's manual for the evaluation of impacts of coal-fired power plants on fish, wildlife and their habitats  
[PB-291330/9] 22 p0373 A79-21679

## WIND (METEOROLOGY)

- Storage development of wind energy --- German technology utilization  
22 p0268 A79-24323
- Preliminary results of a field experiment to characterize wind flow through a vertical plane  
[PNL-2518] 21 p0203 A79-13322
- Applied research on energy storage and conversion for photovoltaic and wind energy systems. Volume 2: Photovoltaic systems with energy storage  
[HCP/T22221-01/2-2] 21 p0207 A79-13510
- Applied research on energy storage and conversion for photovoltaic and wind energy systems. Volume 1: Study summary and concept screening  
[HCP/T22221-01/1-VOL-1] 21 p0207 A79-13511
- Engineering handbook on the atmospheric environmental guidelines for use in wind turbine generator development  
[NASA-TP-1359] 21 p0223 A79-14679
- An operating 200-kW horizontal axis wind turbine  
[NASA-TM-79034] 22 p0333 A79-16357

## WIND DIRECTION

- Wind direction change criteria for wind turbine design  
[PNL-2531] 22 p0361 A79-20506

## WIND EFFECTS

- Dynamic response of a wind turbine system and its effect on performance  
21 p0067 A79-14293
- Generalized wind characteristics and their effect on wind turbine output  
21 p0068 A79-14294
- Effect of dust on flat plate collectors  
21 p0129 A79-17399
- The interaction of the wind field with a horizontal axis wind turbine  
22 p0278 A79-26177

## WIND MEASUREMENT

- Wind direction change criteria for wind turbine design  
[PNL-2531] 22 p0361 A79-20506

## WIND PRESSURE

- Pressure measurements on wind tunnel models of the Aylesbury experimental house  
22 p0300 A79-29372

## WIND PROFILES

- Wind power potential in the Pacific Northwest  
22 p0244 A79-21334

## WIND TUNNEL MODELS

- Pressure measurements on wind tunnel models of the Aylesbury experimental house  
22 p0300 A79-29372

## WIND TUNNEL TESTS

- The design and testing of a vertical-axis wind turbine using sails  
21 p0153 A79-18467
- Fluid dynamics of diffuser-augmented wind turbines  
22 p0238 A79-20798
- Liquefied natural gas wind tunnel simulation and instrumentation assessments  
[SAN-W1364-01] 21 p0195 A79-12256
- Gironill wind tunnel test and analysis, volume 2. Technical discussion  
[COO-2617-4/2] 21 p0204 A79-13378

## WIND VELOCITY

- A comparison of the Weibull and Rayleigh distributions for estimating wind power potential  
21 p0045 A79-12243
- Frequency distribution of wind speed near the surface  
21 p0165 A79-20139
- Energy statistics for large wind turbine arrays  
22 p0299 A79-29371
- Oahu wind power survey  
[PB-287361/0] 22 p0335 A79-16382
- WIND VELOCITY MEASUREMENT
- Wind power site evaluation. I - Wind energy potential. II - Data acquisition and processing  
22 p0257 A79-22924
- An analytical expression for the specific output of wind turbine generators  
22 p0273 A79-25720
- Run duration analysis of surface wind speeds for wind energy application  
22 p0287 A79-27345

## WINDMILLS (WINDPOWERED MACHINES)

- Design and operating experience on the U.S. Department of Energy Experimental Mod-O 100 kW Wind Turbine  
21 p0028 A79-10234
- DOE/NASA Mod-OA wind turbine performance  
21 p0028 A79-10235
- On-line control of a large horizontal axis wind energy conversion system and its performance in a turbulent wind environment  
21 p0028 A79-10236
- Vortex sheet analysis of the Gironill  
21 p0031 A79-10278
- Calculation of wake effects in wind turbine parks  
21 p0045 A79-12241
- Performance prediction methods for horizontal axis wind turbines  
21 p0045 A79-12244
- Low-cost concept for energy supply from the wind  
21 p0058 A79-13651
- A small horizontal axis wind turbine feeding power into the utility grid  
21 p0074 A79-14703
- Wind energy conversion --- review discussing sites and machinery  
21 p0091 A79-15870
- The Campbell Chinese Type Windmill  
21 p0142 A79-17510
- Development of 1 kW vertical axis wind generator  
21 p0142 A79-17511
- An evaluation of the strategy of low cost horizontal axis windmills  
21 p0143 A79-17517
- The design and testing of a vertical-axis wind turbine using sails  
21 p0153 A79-18467
- An analytical expression for the specific output of wind turbine generators  
22 p0273 A79-25720
- Fluids engineering in advanced energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978  
22 p0278 A79-26176
- The interaction of the wind field with a horizontal axis wind turbine  
22 p0278 A79-26177
- A two dimensional vortex sheet model of a Savonius Rotor  
22 p0278 A79-26178

## WINDPOWER UTILIZATION

## SUBJECT INDEX

- Vortex sheet analysis of the Giromill --- vertical axis wind turbine with straight blades 22 p0278 A79-26179
- Wind power distribution, control, and conversion in vortex augmentors --- influence on turbomachinery design and development 22 p0278 A79-26180
- Some flow analyses for Tornado-type wind turbines 22 p0279 A79-26181
- Diffuser designs for improved wind energy conversion 22 p0279 A79-26182
- Induction-generator/synchronous-condenser system for wind-turbine power 22 p0286 A79-27219
- Wind energy --- Book 22 p0287 A79-27327
- The application of hydraulics in the 2,000 kW wind turbine generator 22 p0288 A79-27400
- Evaluation of MOSTAS computer code for predicting dynamic loads in two-bladed wind turbines [AIAA 79-0733] 22 p0298 A79-29007
- A hybrid wind turbine suitable for developing regions. 22 p0323 A79-31455
- Design, instrumentation, and calibration of a vertical axis wind turbine rotor [TID-27754] 21 p0174 A79-10533
- Giromill wind tunnel test and analysis, volume 2. Technical discussion [COO-2617-4/2] 21 p0204 A79-13378
- Two-dimensional analysis of vertical axis windmills 22 p0353 A79-19446
- Wind direction change criteria for wind turbine design [PHL-2531] 22 p0361 A79-20506
- WINDPOWER UTILIZATION**
- Advanced wind furnace systems for residential and agricultural heating and electrical supply applications 21 p0028 A79-10237
- Torque ripple in a vertical axis wind turbine 21 p0029 A79-10239
- Toroidal Accelerator Rotor Platforms for wind energy conversion 21 p0029 A79-10240
- SIMWEST - A simulation model for wind energy storage systems 21 p0029 A79-10241
- Calculation of wake effects in wind turbine parks 21 p0045 A79-12241
- The influence of blade camber on the output of vertical-axis wind turbines 21 p0045 A79-12242
- A comparison of the Weibull and Rayleigh distributions for estimating wind power potential 21 p0045 A79-12243
- Selection of method for calculating the parameters of wind and solar power station storage facilities 21 p0054 A79-13293
- Low-cost concept for energy supply from the wind 21 p0058 A79-13651
- Design of a low-energy house in Denmark heated by a combination of solar and wind energy 21 p0058 A79-13652
- Vacation homes near the sea with solar and wind energy utilization - Research done at the Technical University of Hannover: Architectural considerations 21 p0058 A79-13653
- Total energy systems --- domestic solar and windpowered facilities 21 p0058 A79-13654
- Potential and technical utilization of renewable energy sources 21 p0058 A79-13655
- The wind as a potential energy source in future hydrogen technology 21 p0059 A79-13661
- Solar and wind energy applications in Hawaii 21 p0066 A79-14265
- Alternative energy for domestic hot water - Wind or solar 21 p0067 A79-14292
- The National Program for Solar Energy 21 p0072 A79-14688
- Airfoil data for use of wind turbine designers 21 p0073 A79-14702
- Wind, waves, and tides --- as future energy sources 21 p0074 A79-14719
- Toroidal accelerator rotor platforms for wind energy conversion 21 p0077 A79-14770
- Feature review of some advanced and innovative design concepts in wind energy conversion systems. 21 p0077 A79-14771
- Wind energy conversion --- review discussing sites and machinery 21 p0091 A79-15870
- Energy technology V: Challenges to technology; Proceedings of the Fifth Conference, Washington, D.C., February 27-March 1, 1978 21 p0091 A79-15879
- Large wind turbine generators --- NASA program status and potential costs 21 p0092 A79-15881
- Utility applications of wind power plants 21 p0092 A79-15882
- A proposed conceptual plan for integration of wind turbine generators with a hydroelectric system 21 p0098 A79-16107
- Technical and economic feasibility of making fertilizer from wind energy, water, and air 21 p0142 A79-17512
- Wind generation of electricity for a novel dwelling independent of servicing networks 21 p0142 A79-17513
- A methodology for evaluating the worth of a new energy resource with particular reference to wind energy utilisation in rural areas 21 p0143 A79-17514
- A technique for longitudinal correlation of wind data - Theory and its application to siting of wind power plants 21 p0143 A79-17518
- Wind power and other energy options --- Book 21 p0153 A79-18346
- Wind power potential in the Pacific Northwest 22 p0244 A79-21334
- Wind power site evaluation. I - Wind energy potential. II - Data acquisition and processing 22 p0257 A79-22924
- Stormy development of wind energy --- German technology utilization 22 p0268 A79-24323
- Wind energy - The long road to commercialization 22 p0269 A79-24612
- Wind power distribution, control, and conversion in vortex augmentors --- influence on turbomachinery design and development 22 p0278 A79-26180
- Wind energy --- Book 22 p0287 A79-27327
- Run duration analysis of surface wind speeds for wind energy application 22 p0287 A79-27345
- Energy statistics for large wind turbine arrays 22 p0299 A79-29371
- Pressure measurements on wind tunnel models of the Aylesbury experimental house 22 p0300 A79-29372
- Large-scale introduction of wind power stations in the Swedish grid A simulation study 22 p0300 A79-29373
- Wind power and electric utilities - A review of the problems and prospects 22 p0300 A79-29374
- Limits to wind power utilization 22 p0302 A79-29601
- Some recent developments in wind and ocean power systems 22 p0303 A79-29797
- Sail power for the world's cargo ships 22 p0305 A79-30374
- The economics of electric power generation from wind energy 22 p0310 A79-30998
- Two-dimensional analyses related to wave-energy extraction by submerged resonant ducts 22 p0312 A79-31099
- The role of applied meteorology in the Canadian energy programme 22 p0317 A79-31414
- Wind power from a vortex chamber 22 p0319 A79-31425
- NRC's wind energy program 22 p0319 A79-31426

# SUBJECT INDEX

# WINDPOWERED GENERATORS

- The Prince Edward Island Wind Energy Program 22 p0319 A79-31427
- Design, fabrication, and test of a composite material wind turbine rotor blade [NASA-CR-135389] 21 p0173 N79-10525
- Net energy analysis of five energy systems [ORAU/IEA(R)-77-12] 21 p0174 N79-10534
- Structural performance of the DOE/Sandia 17 meter vertical axis wind turbine [SAND-78-0880C] 21 p0187 N79-11516
- Data acquisition and signal processing for a vertical axis wind energy conversion system [SAND-78-1000C] 21 p0187 N79-11517
- Applied research on energy storage and conversion for photovoltaic and wind energy systems. Volume 3: Wind conversion systems with energy storage [HCP/T22221-01/3] 21 p0189 N79-11535
- Siting handbook for small wind energy conversion systems [PHL-2521] 21 p0209 N79-13527
- Summary of atmospheric wind design criteria for wind energy conversion system development [NASA-TP-1389] 21 p0223 N79-14678
- Oahu wind power survey [PB-287361/0] 22 p0335 N79-16382
- Expert opinion on wind energy conversion systems designed by Hermann Honnef [BMFT-PB-T-77-35] 22 p0349 N79-18456
- Public hearing transcript: Federal non-nuclear energy research and development program [PB-287910/4] 22 p0349 N79-18464
- Stochastic analysis of wind characteristics for energy conversion 22 p0350 N79-18535
- Wind characteristics program element [PHL-2545] 22 p0356 N79-19568
- ## WINDPOWERED GENERATORS
- Design and operating experience on the U.S. Department of Energy Experimental Mod-O 100 kW Wind Turbine 21 p0028 A79-10234
- DOE/NASA Mod-OA wind turbine performance 21 p0028 A79-10235
- On-line control of a large horizontal axis wind energy conversion system and its performance in a turbulent wind environment 21 p0028 A79-10236
- Experimental demonstration of the Diffuser Augmented Wind Turbine concept 21 p0029 A79-10238
- Aeroelastic wind energy converter 21 p0047 A79-12275
- Power extracted from the wind 21 p0058 A79-13650
- Low-cost concept for energy supply from the wind 21 p0058 A79-13651
- Optimum selection of a wind turbine generator system [AIAA PAPER 78-1774] 21 p0062 A79-13871
- The brake system for the DOE/Sandia 17-meter vertical axis wind turbine 21 p0067 A79-14289
- Design of a direct wind energy converter to heat water by agitation in a closed tank 21 p0067 A79-14290
- A low cost blade design for a Darrieus-type vertical-axis wind turbine 21 p0067 A79-14291
- Dynamic response of a wind turbine system and its effect on performance 21 p0067 A79-14293
- Generalized wind characteristics and their effect on wind turbine output 21 p0068 A79-14294
- Generic power performance estimates for wind turbines 21 p0068 A79-14295
- Analysis of wind turbine generator rotor response to one-dimensional turbulence 21 p0077 A79-14768
- Toroidal accelerator rotor platforms for wind energy conversion 21 p0077 A79-14770
- Large filament wound structures for energy and transportation systems --- turbine blades for windpowered energy systems 21 p0086 A79-15507
- Control of wind turbine generators connected to power systems 21 p0086 A79-15574
- Operation and control of wind-electric systems 21 p0086 A79-15575
- Large wind turbine generators --- NASA program status and potential costs 21 p0092 A79-15881
- Utility applications of wind power plants 21 p0092 A79-15882
- A proposed conceptual plan for integration of wind turbine generators with a hydroelectric system 21 p0098 A79-16107
- On the use of eddy-current couplings in wind-driven synchronous machines 21 p0113 A79-16742
- Controlling a wind generator for increased efficiency 21 p0113 A79-16743
- Efficient use of wind energy by using static slip recovery systems - A simulator study 21 p0113 A79-16744
- The Netherlands experimental vertical axis wind turbine 21 p0114 A79-17120
- The Campbell Chinese Type Windmill 21 p0142 A79-17510
- Development of 1 kW vertical axis wind generator 21 p0142 A79-17511
- Wind generation of electricity for a novel dwelling independent of servicing networks 21 p0142 A79-17513
- Field testing of 5-kW commercial wind generator with an automatic load-matching device for utilizing its output 21 p0143 A79-17515
- Vertical axis wind turbine status 21 p0143 A79-17516
- A technique for longitudinal correlation of wind data - Theory and its application to siting of wind power plants 21 p0143 A79-17518
- A minicomputer based data acquisition and analysis systems for vertical axis wind turbine testing 21 p0144 A79-17617
- Some effects of flow curvature on the performance of Darrieus wind turbines [AIAA PAPER 79-0112] 21 p0156 A79-19538
- Wind turbine generator wakes [AIAA PAPER 79-0113] 21 p0156 A79-19539
- Energy effectiveness of arbitrary arrays of wind turbines [AIAA PAPER 79-0114] 21 p0156 A79-19540
- The Madaras Rotor Power Plant - An alternate method for extracting large amounts of power from the wind [AIAA PAPER 79-0115] 21 p0157 A79-19541
- Experimental investigation of the joint operation of wind and solar plants 21 p0167 A79-20358
- Fluid dynamics of diffuser-augmented wind turbines 22 p0238 A79-20798
- An inverse problem of vertical-axis wind turbines 22 p0239 A79-20800
- Background and system description of the Mod 1 wind turbine generator 22 p0239 A79-20825
- Wind turbine generator application places unique demands on tower design and materials 22 p0240 A79-20826
- Fatigue impact on Mod-1 wind turbine design 22 p0240 A79-20827
- Wind-turbine-generator rotor-blade concepts with low-cost potential 22 p0240 A79-20828
- An operating 200 kW horizontal axis wind turbine 22 p0240 A79-20829
- Microprocessor control of a wind turbine generator 22 p0244 A79-21302
- Cost-effectiveness of the vortex-augmented wind turbine 22 p0266 A79-24048
- Tropospheric conduits --- for pollution abatement and energy production 22 p0266 A79-24275
- Stormy development of wind energy --- German technology utilization 22 p0268 A79-24323

## WINDPOWERED PUMPS

- An analytical expression for the specific output of wind turbine generators 22 p0273 A79-25720
- Contribution to the development of wind energy systems using static power electronic converters 22 p0286 A79-26958
- No ill winds for New Mexico utility --- windpower utilization in municipal electric power system 22 p0286 A79-27208
- Wind energy --- Book 22 p0287 A79-27327
- The application of hydraulics in the 2,000 kW wind turbine generator 22 p0288 A79-27400
- Energy statistics for large wind turbine arrays 22 p0299 A79-29371
- A Variable Speed Constant Frequency /VSCF/ wind generator for low power applications 22 p0303 A79-29799
- Control strategy for a variable-speed wind energy conversion system 22 p0303 A79-29800
- The economics of electric power generation from wind energy 22 p0310 A79-30998
- Wind power from a vortex chamber 22 p0319 A79-31425
- NRC's wind energy program 22 p0319 A79-31426
- Alternate energy installations on the Jordan College Campus 22 p0323 A79-31454
- Design and application of large wind turbine generators 22 p0326 A79-31916
- Off-shore multi-MW size wind turbine system development is the key to cost-effective wind energy for Sweden 22 p0326 A79-31917
- Reliability of wind power from dispersed sites: A preliminary assessment [LBL-6889] 21 p0176 N79-10547
- Transient response to three-phase faults on a wind turbine generator 21 p0180 N79-11312
- Nonlinear dynamic response of wind turbine rotors [NASA-TM-78324] 21 p0195 N79-12542
- Microprocessor control of a wind turbine generator [NASA-TM-79021] 21 p0195 N79-12548
- Lightning protection for the vertical axis wind turbine [SAND-77-1241] 21 p0221 N79-14567
- Engineering handbook on the atmospheric environmental guidelines for use in wind turbine generator development [NASA-TP-1359] 21 p0223 N79-14679
- Aeroelastic response and stability of a coupled rotor/support system with application to large horizontal axis with turbines 22 p0332 N79-16346
- Power train analysis for the DOE/NASA 100-kW wind turbine generator [NASA-TM-78997] 22 p0333 N79-16355
- An operating 200-kW horizontal axis wind turbine [NASA-TM-79034] 22 p0333 N79-16357
- Oahu wind power survey [PB-287361/0] 22 p0335 N79-16382
- A 200-kW wind turbine generator conceptual design study [NASA-TM-79032] 22 p0341 N79-17333
- Energy analyses applied to ocean thermal energy conversion and an offshore wind power system 22 p0353 N79-19442
- Utility operational experience on the NASA/DOE MOD-0A 200-kW wind turbine [NASA-TM-79084] 22 p0360 N79-20494
- Evaluation of MOSTAS computer code for predicting dynamic loads in two bladed wind turbines [NASA-TM-79101] 22 p0368 N79-21549
- WINDPOWERED PUMPS**
- A comparison between sun and wind as energy sources in irrigation plants 21 p0118 A79-17295
- An evaluation of the strategy of low cost horizontal axis windmills 21 p0143 A79-17517
- WINGLETS**
- Winglets give USAF KC-135 new look in life 22 p0265 A79-23975

## SUBJECT INDEX

- WINTER**
- Design of solar heating system for winter heating of buildings /A case study/ 21 p0139 A79-17486
- Comprehensive overview of winter energy data bulletins [PB-282787/1] 21 p0177 N79-10565
- WIRE WINDING**
- Theoretical and computational analysis of MHD machines with two-layer windings and half-filled slots and the inductor edges 22 p0298 A79-29286
- WOOD**
- Energy from biomass through hydrolysis of wood 21 p0003 A79-10036
- Forest residues as an alternate energy source 21 p0072 A79-14689
- Advanced processes for more efficient use of forest products residual material 21 p0096 A79-15919
- A theoretical study of wood gasification processes 22 p0257 A79-22923
- An evaluation of wood-waste energy conversion systems 21 p0174 N79-10528
- Methanol from wood waste: A technical and economic study [FPL-12] 21 p0194 N79-12239
- PLANE: Forestry Lands Allocated for Managing energy. Feasibility study [AD-A059993] 21 p0217 N79-14507
- WORKING FLUIDS**
- Hydrocarbon working fluid and operating conditions selection for the conventional geothermal binary cycle 21 p0015 A79-10124
- The Arbonia control concept - Does flow regulation in the solar system cycle make sense --- working fluid regulation in solar heating facility 21 p0056 A79-13632
- Plasma diagnostics in an MHD installation 21 p0106 A79-16492
- Performance studies of a finned heat pipe latent thermal energy storage system 21 p0121 A79-17325
- Liquid solar collector --- low cost assemblage with black water working fluid 21 p0133 A79-17433
- Solar ammonia-water absorption system for cold storage application 21 p0143 A79-17521
- Design of a solar energy operated lithium-bromide water absorption refrigeration system for refrigeration storage 21 p0143 A79-17523
- Some aspects of the transient response of a flat-plate solar energy collector 21 p0153 A79-18466
- Geothermal power and water production studies at the University of California [ASME PAPER 78-WA/ENER-7] 21 p0159 A79-19778
- The use of heat exchangers with THERMOEXCEL's tubing in ocean thermal energy power plants [ASME PAPER 78-WA/HT-65] 21 p0162 A79-19825
- Using N2O4 in a solar gas-turbine plant 21 p0167 A79-20357
- Effect of the properties of the working body on the selection of the temperature of the surface of the electrodes of the channel of an MHD generator 21 p0167 A79-20419
- Study of solid-gas-suspensions used for direct absorption of concentrated solar radiation 22 p0262 A79-23757
- Solar energy storage as hydrogen and bromine from hydrogen bromide 22 p0265 A79-24045
- Solar system modeling using a modular approach with generalized programs for working fluid properties 22 p0266 A79-24310
- Effects of test fluid, flow rate, and flow regime on solar collector thermal performance measurements 22 p0268 A79-24317
- Use of organic fluids in solar turbines 22 p0269 A79-24621
- Working fluids and turbines for OTEC power systems 22 p0280 A79-26192

# SUBJECT INDEX

# ZIRCONIUM OXIDES

Heat transfer in a solar radiation absorbing fluid  
layer flowing over a substrate 22 p0281 A79-26204

Solar energy application of natural zeolites ---  
solid absorber-water vapor working fluid system  
for sorption-refrigeration cycles 22 p0286 A79-27213

Thermal analysis of black liquid cylindrical  
parabolic collector 22 p0295 A79-28354

Power cycles and working fluids for low  
temperature heat sources 22 p0332 A79-16268

## ZIRCONIUM ALLOYS

The effect of induced disorder on the  
hydrogenation behaviour of the phase ZrCo 22 p0251 A79-21707

## ZIRCONIUM OXIDES

Electrochemical characteristics of ZrO<sub>2</sub>-Y<sub>2</sub>O<sub>3</sub> solid  
electrolytes for fuel cells 21 p0039 A79-11813

## X

### X RAY IMAGERY

Two-dimensional monochromatic X-ray imaging of  
laser-produced plasmas --- during implosions for  
laser fusion 22 p0296 A79-28366

### X RAY SPECTRA

Measurements of compressed core density of  
laser-imploded targets by x-ray continuum-edge  
shift 21 p0154 A79-18479

Pellet X-ray spectra for laser fusion reactor  
designs 22 p0291 A79-27878

### XENON LAMPS

Proposal for efficient appreciation of solar  
thermal absorptive materials by high irradiance  
solar simulator 21 p0130 A79-17406

## Y

### YAG LASERS

Frequency doubling of a solar pumped Nd:YAG laser  
21 p0044 A79-12062

Performance of the short-pulse oscillators for  
Argus and Shiva 21 p0083 A79-15171

Optical coatings for a space laser communications  
system 22 p0292 A79-28028

### YOKES

Accounting for the effect of a yoke in an MHD  
linear induction machine by stipulating boundary  
conditions of a new kind 22 p0247 A79-21627

### YTTRIUM OXIDES

Electrochemical characteristics of ZrO<sub>2</sub>-Y<sub>2</sub>O<sub>3</sub> solid  
electrolytes for fuel cells 21 p0039 A79-11813

## Z

### ZAMBIA

Description of hydro-electric development and  
proposal for future development on the Zambezi  
22 p0340 A79-17323

### ZEOLITES

Solar energy application of natural zeolites ---  
solid absorber-water vapor working fluid system  
for sorption-refrigeration cycles 22 p0286 A79-27213

### ZETA PINCH

Microstability of a focused ion beam propagating  
through a z-pinch plasma 22 p0270 A79-24817

Plasma behavior near the neutral line between  
parallel currents --- in planar zeta pinch 22 p0324 A79-31754

### ZINC

Thermodynamic and kinetic considerations on  
zinc-halogen batteries 21 p0040 A79-11822

Electrolysis of zinc. Statistical model of the  
process parameters for an industrial cell  
[BLL-RTS-11317] 22 p0345 A79-17984

### ZINC COMPOUNDS

100MWh zinc-chlorine peak-shaving battery plants  
21 p0011 A79-10096

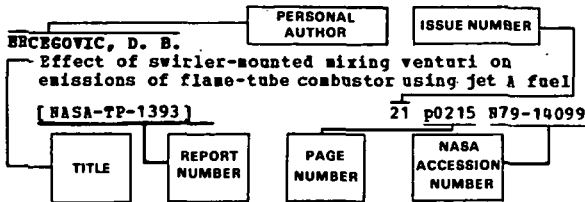
Photovoltaic effects in II-VI heterojunctions  
21 p0042 A79-11967

# PERSONAL AUTHOR INDEX

ENERGY / A Continuing Bibliography (Issue 22)

JULY 1979

## Typical Personal Author Index Listing



Listings in this index are arranged alphabetically by personal author. The title of the document provides the user with a brief description of the subject matter. The report number helps to indicate the type of document listed (e.g., NASA report, translation, NASA contractor report). The issue, page and accession numbers are located beneath and to the right of the title, e.g., 21 p0215 879-14099. Under any one author's name the accession numbers are arranged in sequence with the /AA accession numbers appearing first.

## A

- ABATUT, J. L.**  
Analysis and design of a field of heliostats for a solar power plant 22 p0242 879-21161
- ABDEL-KHALIK, S. I.**  
Properties optimization for phase-change energy storage in air-based solar heating systems 21 p0149 879-18018
- ABDEL-SALAM, O.**  
Molten-carbonate CO<sub>2</sub> concentrator - Preliminary experiments [ASME PAPER 78-ENAS-2] 21 p0048 879-12551
- ABDELRAHMAN, E.**  
Study of solid-gas-suspensions used for direct absorption of concentrated solar radiation 22 p0262 879-23757
- ABDERASSOUL, R.**  
High-efficiency thin-film polycrystalline-silicon solar cells 22 p0273 879-25744
- ABELS, T. P.**  
Parameters for legislative consideration of bioconversion technologies [PB-284742/4] 21 p0194 879-12250
- ABNAT, A.**  
Investigation of physical and chemical properties of phase change materials for space heating/cooling applications 21 p0120 879-17319
- Performance studies of a finned heat pipe latent thermal energy storage system** 21 p0121 879-17325
- ABRAHAM, K. H.**  
A lithium/dissolved sulfur battery with an organic electrolyte 22 p0305 879-30332
- ABRAHOWITZ, S.**  
Test procedures for the determination of the gross caloric value of refuse and refuse-derived-fuels by oxygen bomb calorimetry: Summary of the 1977 fiscal year results [PB-290160/1] 22 p0364 879-21167
- ABRIKOSOV, B. KH.**  
Study of diffusion processes in low-temperature thermopiles 21 p0054 879-13290
- ABUL-FADL, A.**  
Material growth and characterization directed toward improving III-V heterojunction solar cells [NASA-CR-158476] 22 p0367 879-21543
- ACHAIBOU, A.**  
Analysis and design of a field of heliostats for a solar power plant 22 p0242 879-21161
- ACHARD, J. C.**  
Hydrogen electrochemical storage by substituted LaNi<sub>5</sub> compounds 22 p0251 879-21711
- ACKERMAN, J. P.**  
Molten carbonate fuel cell systems - Status and potential 21 p0039 879-11817
- Development of central station power plants integrated with coal gasifiers** 21 p0093 879-15895
- ACKERMAN, R.**  
Design of superconducting magnets for full-scale MHD generators 21 p0084 879-15306
- ACKERMAN, S. L.**  
Practical aspects of designing and manufacturing MHD superconducting base-load magnets in 1988 time frame 22 p0235 879-20535
- ACTON, R. G.**  
Prospects for improvements in lead-acid batteries 22 p0300 879-29488
- ADDRO, A.**  
Selective covers for natural cooling devices 22 p0272 879-25522
- ADDIE, A. H.**  
Energy requirements of the rail mode [ASME PAPER 78-RT-1] 21 p0150 879-18085
- ADIBHATLA, S.**  
Computer aided optimization of integrated coal gasification combined cycle power plants 21 p0008 879-10075
- ADKINS, C. H.**  
New alloy systems for hydrogen storage 21 p0038 879-11806
- APPENS, W. A.**  
Further studies of fuels from alternate sources: Fire extinguishment experiments with JP-5 jet turbine fuel derived from shale [AD-A058586] 21 p0201 879-13182
- APIAN, V. V.**  
Controlling the radiant flux of a high-temperature solar energy conversion system over two parameters 22 p0296 879-28669
- AGABAEV, CH.**  
Determination of thermal contact resistances 21 p0166 879-20351
- AGAPONOV, A. V.**  
Demetallization catalyst tests on heavy residual oils [PB-285937/9] 21 p0232 879-15864
- AGARWAL, K. H.**  
Design of radiometer for measurement of total and net exchange solar radiation 21 p0119 879-17307
- AGARWALA, A.**  
Response of a solar cell to intense and nonuniform illumination when used with solar concentrators 21 p0125 879-17357
- AGAWA, T.**  
Optimum power plant capacity of ocean-based ocean thermal energy conversion systems 22 p0297 879-28922
- AGEYEN, G.**  
Use of waste heat from thermal electric power plants and nuclear power plants to heat greenhouses [ORNL-TR-4483] 21 p0221 879-14574



- AGGARWAL, R.**  
An analysis of fuel conserving operational procedures and design modifications for bomber/transport aircraft. Volume 1: Executive summary  
[AD-A061746] 22 p0351 N79-18969
- AGGARWAL, R. K.**  
An analysis of fuel conserving operational procedures and design modifications for bomber/transport aircraft, volume 2  
[AD-A062609] 22 p0356 N79-20109
- AGNEW, C. E.**  
Impact of electric passenger automobiles on utility system loads, 1985 - 2000  
[EPRI-EA-623] 21 p0203 N79-13281
- AGNIHOTRI, O. P.**  
Preparation and properties of pure and tin doped indium oxide selective coatings  
21 p0127 A79-17381
- AGREIN, B.**  
Utility fuel cells for biomass fuel  
21 p0016 A79-10131
- AHLSTROM, E. G.**  
Diagnostics of Shiva Nova high-yield thermonuclear events  
22 p0285 A79-26747
- AHLUWALIA, R. K.**  
Two-dimensional MHD channel design  
Parametric study of the performance of a CDIF 1-B coal-fired MHD generator  
[ANL-MHD-79-3] 22 p0361 N79-20503
- AHMAD, A.**  
Recovery of oil from oil shale - An overall technological perspective  
21 p0073 A79-14698
- AHMADI, G.**  
Aeroelastic wind energy converter  
Yield of ground storage of heat in solar ponds  
Computer simulation of the performance of a solar pond in the southern part of Iran  
21 p0047 A79-12275  
21 p0133 A79-17429  
21 p0133 A79-17432
- AHMED, S.**  
A multivariate-utility approach for selection of energy sources  
21 p0098 A79-16120
- AHMED, S. B.**  
Analysis of thermal storage unit for solar energy  
21 p0122 A79-17332
- AHNER, D. J.**  
Integrated low Btu gasification, combined cycle plant considerations and control  
Study of integrated gasification combined cycle plant interaction and control  
[ASME PAPER 79-GT-60] 22 p0306 A79-30530
- AHRENS, P. W.**  
Ejector augmentation of the air supply in a compressed air energy storage plant  
Performance of a hydraulic air compressor for use in Compressed Air Energy Storage power systems  
21 p0013 A79-10109  
22 p0280 A79-26191
- AI, D. K.**  
A low cost blade design for a Darrieus-type vertical-axis wind turbine  
21 p0067 A79-14291
- AIKAWA, S.**  
Effect of physical properties of a flat plate solar collector cover on efficiency calculations - Simplifying hypotheses  
21 p0164 A79-19949
- AIKEN, R.**  
Biomass utilization in Minnesota  
[PB-282531/3] 21 p0171 N79-10241
- AIZAWA, K.**  
Optimum design parameters of horizontal coaxial cylinders for a solar energy collector  
21 p0134 A79-17444
- AKBARZADEH, A.**  
Yield of ground storage of heat in solar ponds  
Computer simulation of the performance of a solar pond in the southern part of Iran  
21 p0133 A79-17432
- AKHTAR, S.**  
Moessbauer spectroscopy of iron in coal and coal hydrogenation products  
22 p0282 A79-26464
- AKIYAMA, M.**  
The utilization of LH2 and LNG cold for generation of electric power by a cryogenic-type Stirling engine  
22 p0311 A79-31020
- ALBAUGH, L. B.**  
Risk control in the development of energy processes  
21 p0085 A79-15372
- ALCONE, J. M.**  
Analysis and design of air heating unglazed flat plate solar collectors  
22 p0280 A79-26202
- ALCORN, W. R.**  
Catalyst development program for hydrodesulfurization and liquefaction of coal to produce clean boiler fuels  
[FE-2321-12] 21 p0216 N79-14240
- ALDERFER, R. G.**  
Assessing environmental costs of energy procurement  
21 p0071 A79-14682
- ALDRIDGE, H. H.**  
The preparation of some novel electrolytes: Synthesis of partially fluorinated alkane sulfonic acids as potential fuel cell electrolytes  
[AD-A056278] 21 p0184 N79-11483
- ALFELD, G.**  
Basic physical and chemical processes for storage of heat  
Efficiency improvement by means of multicomponent processes - Improvement of the efficiency of heat-power transformation by means of an employment of Clausius-Rankine sorption processes  
21 p0038 A79-11805  
21 p0164 A79-19975
- ALEXANDER, G.**  
The development of a 37 kW solar-powered irrigation system  
21 p0144 A79-17525
- ALEXANDER, W. E.**  
Material growth and characterization directed toward improving III-V heterojunction solar cells  
[NASA-CR-158476] 22 p0367 N79-21543
- ALGERHISEN, J.**  
Theoretical studies of coal pyrolysis in an entrained bed flow reactor  
21 p0007 A79-10063
- ALIZADEH, S.**  
Design and optimization of an absorption refrigeration system operated by solar energy  
22 p0285 A79-26819
- ALLEN, C. A.**  
Liquid-fluidized-bed heat exchanger flow distribution models  
[ICP-1151] 22 p0369 N79-21559
- ALLEN, F. G.**  
Effect of grain boundaries in silicon on minority-carrier diffusion length and solar-cell efficiency  
22 p0252 A79-21807
- ALLEN, R.**  
The CCMS solar energy pilot study system performance reporting format  
22 p0275 A79-25930
- ALLEN, R. W.**  
Stochastic simulation experiments on solar air conditioning systems  
Stochastic predictions of solar cooling system performance  
[ASME PAPER 78-WA/SOL-16] 21 p0164 A79-19848  
Report of the 4th CCMS (Committee on the Challenges of Modern Society) Solar Energy Pilot Study Meeting  
[PB-289492/1] 22 p0372 N79-21631
- ALLEN, T.**  
Brookhaven National Laboratory burner-boiler/furnace efficiency test project. Annual fuel use and efficiency reference manual: hydronic equipment  
[BNL-50816] 21 p0210 N79-13538
- ALLRED, D. D.**  
Chemical vapor deposited molybdenum films for use in photothermal conversion  
22 p0294 A79-28148

PERSONAL AUTHOR INDEX

ARTOINE, A. C.

- Chemical vapor deposited amorphous silicon for use  
in photothermal conversion 22 p0294 A79-28149
- ALLUMS, S. L.  
Performance characteristics of a 1.8 by 3.7 meter  
Fresnel lens solar concentrator  
[NASA-TM-78222] 22 p0360 N79-20495
- ALBANZA, R.  
Total solar radiation in Mexico using sunshine  
hours and meteorological data 21 p0150 A79-18026
- ALONSO, M.  
Solar energy in Latin America - An overview 21 p0116 A79-17279
- ALPER, M. E.  
Photovoltaics and solar thermal conversion to  
electricity - Status and prospects 22 p0326 A79-31924
- ALPERT, S. B.  
Coal liquefaction - Status and new directions 21 p0007 A79-10062
- ALTER, H.  
Development of specifications for recycled products 22 p0295 A79-28182
- ALTHANN, H.  
A wave power machine using free floating vertical  
plates 21 p0151 A79-18104
- ALTSCHULER, S. J.  
Geothermal power from salt domes 21 p0014 A79-10120
- ALVAREZ, I. S.  
Anticonvective antiradiative systems 21 p0132 A79-17420
- ALVIS, R. L.  
Solar powered irrigation: Present status and  
future outlook  
[SAND-78-0016C] 21 p0175 N79-10539  
Solar irrigation program plan: Second revision  
[SAND-78-0308-REV] 21 p0187 N79-11525  
Solar irrigation program  
[SAND-78-0049] 21 p0210 N79-13537
- AMATO, R. V.  
Remote sensing and mine subsidence in Pennsylvania 22 p0303 A79-29936
- AMEEL, T. A.  
Experimental measurements and correlations of  
Nusselt number for MHD high temperature air  
preheaters  
[ASME PAPER 78-WA/HT-22] 21 p0161 A79-19809
- AREND, W. E.  
MHD power plant characteristics 21 p0105 A79-16480
- ARIN, H.  
Evaluation of the use of oxygen as oxidant in  
fossil fuel fired open cycle MHD-steam energy  
conversion processes 22 p0353 N79-19444
- ARAND, D. K.  
Stochastic simulation experiments on solar air  
conditioning systems 21 p0138 A79-17474  
Use of solar energy for industrial process heat 21 p0143 A79-17524  
Stochastic predictions of solar cooling system  
performance  
[ASME PAPER 78-WA/SOL-16] 21 p0164 A79-19848
- ARAVIN, S. I.  
Structure of the current shell in a Z pinch 22 p0245 A79-21434
- ARATICHUK, L. I.  
Thermal converters with transverse  
thermoelectromotive forces 22 p0256 A79-22847
- ANDERSON, A. P.  
Hydrides for energy storage; Proceedings of the  
International Symposium, Geilo, Norway, August  
14-19, 1977 22 p0247 A79-21676
- ANDERSON, A. W.  
Gas turbine operating and maintenance experience  
in Saudi Arabia 22 p0298 A79-28989
- ANDERSON, B. B.  
Passive solar design 21 p0074 A79-14720
- ANDERSON, D. E.  
Effect of inlet temperature on the performance of  
a catalytic reactor 21 p0035 A79-11542
- ANDERSON, J. E.  
Remote monitoring of coal strip mine rehabilitation  
[PB-286647/3] 21 p0228 N79-15379
- ANDERSON, J. H.  
Progress in nuclear-pumped lasers 21 p0110 A79-16627
- ANDERSON, O. L.  
Local perceptions of energy development: The case  
of the Kaiparowits Plateau  
[PB-287314/9] 22 p0335 N79-16380
- ANDERSON, P.  
Solar absorption cooling 21 p0090 A79-15861
- ANDERSON, P. H.  
The impact of advanced technology on the future  
electric energy supply problem 21 p0112 A79-16736
- ANDERSON, R. H.  
Linear echelon refractor/reflector solar  
concentrators 22 p0293 A79-28143
- ANDERSON, V. R.  
Progress report on hydrogen production and  
utilization for community and automotive power 21 p0016 A79-10132
- ANDERSON, W. A.  
Reliability studies on MIS solar cells 21 p0148 A79-17950  
Heat exchanges and columnar growth in  
electron-beam evaporation of silicon films for  
solar cell applications 22 p0272 A79-25084  
Silicon Schottky photovoltaic diodes for solar  
energy conversion  
[PB-283998/3] 21 p0198 N79-12572  
Silicon Schottky photovoltaic diodes for solar  
energy conversion  
[PB-287417/0] 22 p0343 N79-17349
- ANDERSEN, A. F.  
Structural studies of hydrides by neutron  
diffraction 22 p0248 A79-21681  
Hydrogen storage in FeTi - Surface segregation and  
its catalytic effect on hydrogenation and  
structural studies by means of neutron diffraction 22 p0312 A79-31156
- ANDRIUSHCHENKO, A. I.  
Thermodynamic basis for combining cycles of heat  
producing power plants 22 p0298 A79-29297
- ANGELINO, G.  
The use of liquid natural gas as heat sink for  
power cycles 22 p0332 N79-16262  
Development of thermal prime movers for heat pump  
drive 22 p0332 N79-16263
- ANGELLO, J.  
Military thermoelectric power sources 21 p0027 A79-10227  
Regenerative burner system for thermoelectric  
power sources 22 p0261 A79-23621
- ANGELLO, L. C.  
Shale oil - The answer to the jet fuel  
availability question  
[SAE PAPER 781027] 22 p0274 A79-25900  
Behavior of nonmetallic materials in shale oil  
derived jet fuels and in high aromatic and high  
sulfur petroleum fuels  
[AD-A060322] 21 p0226 N79-15203
- ANSARI, J. S.  
Receiver designs for tower-top solar collector 21 p0135 A79-17450
- ANTHONY, K.  
MSFC hot air collectors  
[NASA-TM-78206] 21 p0196 N79-12556
- ANTHONY, R. G.  
Synthetic fuels from Gulf Coast lignite 21 p0146 A79-17643
- ARTOINE, A. C.  
Evaluation of the application of some gas  
chromatographic methods for the determination of  
properties of synthetic fuels 22 p0274 A79-25917

- Evaluation of the application of some gas chromatographic methods for the determination of properties of synthetic fuels [NASA-TM-79035] 22 p0338 N79-16930
- ANTONOV, B. E.  
Inverter systems 21 p0106 A79-16486
- Dynamic characteristics of a free-piston diesel engine combined with a MHD generator 22 p0258 A79-23137
- ANTRIM, W. D.  
Design of a second generation concentrating tracking solar collector [AIAA PAPER 78-1775] 21 p0062 A79-13872
- ANTRIM, W. D., JR.  
A flat plate multiple pass solar collector using aqueous optical properties 22 p0293 A79-28144
- A parabolic solar reflector for accurate and economic producibility 22 p0293 A79-28145
- APOLLONSKII, S. M.  
Calculation of the external electromagnetic field of closely spaced MHD machines 22 p0298 A79-29285
- APOSTOLAKIS, G. C.  
Alternative energy sources for Federal Aviation Administration facilities [AD-A058681] 21 p0196 N79-12555
- APPELDORN, E. H.  
Linear echelon refractor/reflector solar concentrators 22 p0293 A79-28143
- APPLEBY, A. J.  
Advanced electrolysis in alkaline solution 21 p0037 A79-11798
- APPS, J. A.  
Definition of engineering development and research problems relating to the use of geothermal fluids for electric power generation and nonelectric heating [LBL-7025] 21 p0188 N79-11534
- ARAPA, A.  
A parametric investigation on flat-plate solar collectors 21 p0128 A79-17391
- ARANOVITCH, E.  
Experiments in solar space heating and cooling for moderately insulated regions 21 p0137 A79-17464
- ARATA, W. H., JR.  
Very large vehicles - To be or 22 p0306 A79-30484
- ARCHER, D. H.  
Circulating-bed boiler concepts for steam and power generation 21 p0008 A79-10071
- ARCHER, S. R.  
Source assessment: Open mining of coal. State of the Art [PB-288497/1] 22 p0353 N79-19429
- ARDEN, W. E.  
Specular mirrors for solar energy application 21 p0034 A79-11147
- ARENS, E. A.  
Geographical variation in the heating and cooling requirements of a typical single-family house, and correlation of these requirements to degree days [PB-289204/0] 22 p0355 N79-19467
- ARIAS, A.  
The economics and policy of alternative energy sources - A review 21 p0103 A79-16454
- ARMANTROUT, J. D.  
Silver-hydrogen, a long life light weight energy storage system 21 p0001 A79-10012
- ARMSTEAD, B. C. H.  
Geothermal energy: Its past, present and future contributions to the energy needs of man 22 p0252 A79-21825
- ARMSTRONG, E.  
Multidisciplinary research related to the atmospheric sciences [PB-283076/8] 21 p0179 N79-10679
- ARMSTRONG, P. R.  
Instrumentation, data acquisition and monitoring system for an air heating solar system 21 p0088 A79-15836
- Space heating with solar all-air systems - CSU Solar House II 21 p0137 A79-17467
- ARNAS, O. A.  
On an irreversible thermodynamic analysis of thermoelectric devices 22 p0260 A79-23609
- ARNOLD, E.  
Substitute natural gas from coal using high-temperature reactor heat - Project 'Prototype Plant Nuclear Process Heat' 22 p0264 A79-23827
- ARNOLD, G. D.  
Environmental considerations for the microwave beam from a solar power satellite 21 p0003 A79-10030
- Design considerations for solar power satellites 21 p0113 A79-16738
- ARNOLD, W.  
A pilot line for the production of large area Cu<sub>x</sub>/S-CdS solar cells 21 p0124 A79-17351
- ARNOLD, E. C.  
Heavy-ion beam inertial-confinement fusion 21 p0054 A79-13448
- ARORA, J. D.  
Temperature dependence of photovoltaic solar energy conversion for GaAs homojunction solar cell 22 p0256 A79-22768
- ARTEMENKOV, L. I.  
Experiments on controlling the plasma density in the TO-1 tokamak 22 p0324 A79-31762
- ARUNASALAM, V.  
Recent results from the PLT tokamak 21 p0069 A79-14453
- ARVIZU, D. E.  
The USA SEM solar thermal test facility 21 p0135 A79-17449
- ASAHINA, T.  
A thermal storage analysis on packed bed of alumina spheres 21 p0121 A79-17324
- ASANUMA, M.  
Hydride formation of C14-type Ti alloy 22 p0250 A79-21701
- ASBURY, J. G.  
The interface with solar - Alternative auxiliary supply systems 21 p0137 A79-17468
- ASCHER, E.  
Is there repair after failure 21 p0086 A79-15378
- ASH, B. L.  
Feasibility of rocket propellant production on Mars 21 p0047 A79-12324
- ASHTON, W.  
Energy analysis of an aluminum solar collector 22 p0316 A79-31405
- ASHUSSEN, J.  
An analytical expression for the specific output of wind turbine generators 22 p0273 A79-25720
- ASPINES, J. D.  
Reducing combustion air temperature variations in magnetohydrodynamic/steam power plants 21 p0016 A79-10135
- Magnetohydrodynamic/steam power plant modeling and control 21 p0046 A79-12274
- ASSELMAN, G. A. A.  
A Stirling engine heat pump system 21 p0024 A79-10206
- ATHERTON, E. W.  
A fundamental model for the evolution of a two-phase geothermal reservoir with application to environmental impact analysis 22 p0263 A79-23777
- ATKINSON, D. W.  
Heating and confinement in the CLEO stellarator 21 p0070 A79-14459

- ATRAZHEV, V. A.**  
The electric conductivity of a plasma of  
combustion products of hydrocarbon fuels with  
alkali impurity  
21 p0167 A79-20415
- ATTALLA, A.**  
NMR studies of hydrogen relaxation and diffusion  
in TiFeH/x/ and TiFe/1-y/Mn/y/H/x/  
22 p0248 A79-21684
- ATWATER, M. A.**  
A numerical solar radiation model based on  
standard meteorological observations  
21 p0041 A79-11871  
Computation of IR sky temperature and comparison  
with surface temperature  
21 p0042 A79-11875
- AUDIBERT, M.**  
Solar thermal conversion installations in the  
medium power range - The Thek project  
22 p0254 A79-22269
- AUDIT, T. E.**  
Performance of combined solar-heat pump systems  
22 p0285 A79-26817
- AUGENSTEIN, D. C.**  
Engineering analysis of in situ liquefaction of coal  
21 p0032 A79-10521
- AUGUST, W.**  
Simple high-accuracy diode temperature-difference  
control circuit  
21 p0056 A79-13631
- AUSLANDER, D. H.**  
An optimal standard for solar heating systems  
[ASME PAPER 78-WA/DSC-19] 21 p0159 A79-19765
- AUTHIER, B. P.**  
P.E.R.I.C.L.E.S. - Design of a stationary  
spherical collector  
21 p0134 A79-17441
- AUXER, W. L.**  
Performance of a Stirling engine powered heat  
activated heat pump  
21 p0011 A79-10098
- AVRZOV, B. R.**  
Study of the temperature distribution across the  
width of the screen of low-temperature water  
heaters with tubular heat receivers  
22 p0297 A79-28671
- AVROBIN, E. H.**  
Hybrid reactor based on laser-induced  
thermonuclear fusion  
21 p0032 A79-10658
- AWAYA, H. I.**  
High temperature thermal energy storage in moving  
sand  
21 p0012 A79-10103
- AXELROD, M. C.**  
A methodology for assessing the potential impact  
on air quality resulting from geothermal  
resource development in the Imperial Valley  
21 p0116 A79-17262
- AYERS, J. W.**  
Design study of superconducting magnets for a  
combustion magnetohydrodynamic /MHD/ generator  
21 p0084 A79-15305  
Fabrication and assembly considerations for a base  
load MHD superconducting magnet system  
22 p0235 A79-20534
- AYHAR, R.**  
Conceptual design of a superconducting tokamak -  
'TORUS II SUPRA'  
22 p0236 A79-20543
- AYRAUD, S.**  
Santa Clara Community Center Project, USA  
22 p0277 A79-25945
- AZIMOV, S. A.**  
Photoelectric properties of pCdTe-nCdS film  
heterojunctions  
21 p0166 A79-20347
- B**
- BABANIN, V. I.**  
Optimization of a Knudsen Cs-Ba thermionic converter  
22 p0241 A79-20940
- BABAYIGIT, B.**  
Investigations of solar heat production for  
household heating in Turkey  
22 p0253 A79-22265
- BABCOCK, W. B.**  
Economic feasibility of solar water and space  
heating  
22 p0292 A79-27899
- BACH, W.**  
Climatic change in connection with energy growth  
22 p0284 A79-26623
- BACHMANN, K. J.**  
High efficiency solar cells based on indium  
phosphide  
21 p0042 A79-11968
- BACKUS, C. E.**  
Can solar energy contribute significantly to the  
solution of the world's energy famine  
21 p0019 A79-10155  
The status of solar energy  
21 p0115 A79-17219  
An overview of photovoltaic power systems  
[ASME PAPER 79-SOL-12] 22 p0308 A79-30547
- BADCOCK, C. C.**  
A state of charge monitor for sealed lead-acid cells  
[ATR-78(8114)-2] 21 p0220 A79-14558
- BAER, D. A.**  
Synchronous meteorological and geostationary  
operational environmental satellites battery and  
power system design  
22 p0370 A79-21571
- BAERT, D.**  
Solar-cell panel simulator  
22 p0265 A79-23867
- BAGDONAS, A. V.**  
Effect of the properties of the working body on  
the selection of the temperature of the surface  
of the electrodes of the channel of an MHD  
generator  
21 p0167 A79-20419
- BAGGE, C. E.**  
Coal - Meeting the energy challenge  
21 p0147 A79-17647
- BARADORI, H. W.**  
Solar water pumping  
21 p0066 A79-14266  
Conceptual development of a solar town in Iran  
21 p0138 A79-17469
- BARAR, F.**  
Design and optimisation of an absorption  
refrigeration system operated by solar energy  
22 p0285 A79-26819
- BAILEY, C. E., JR.**  
High energy metal hydride fuel cell power source  
[AD-A056491] 21 p0184 A79-11485
- BAILEY, E. H.**  
The oxidation of sulfur dioxide to sulfate  
aerosols in the plume of a coal-fired power plant  
21 p0076 A79-14757
- BAILEY, J. E.**  
Energy systems: An analysis for engineers and  
policy makers  
21 p0114 A79-17218
- BAILEY, J. H.**  
Dynamics and feedback control of ISX tokamak  
21 p0107 A79-16559
- BAILEY, V. L.**  
Characterization of electron and ion current flow  
in very large aspect-ratio terawatt diodes  
employing heated and unheated anodes  
21 p0154 A79-18480
- BAILIN, R. C.**  
Energy conversion engineering  
22 p0302 A79-29575
- BAIN, C. H.**  
Power from space by laser  
22 p0284 A79-26596
- BAIR, V. L.**  
Diminide thermionic energy conversion with  
lanthanum-hexaboride electrodes  
21 p0053 A79-13098
- BAKER, C. B.**  
Study of hydrogen recovery systems for gas vented  
while refueling liquid-hydrogen fueled aircraft  
[NASA-CR-158991] 22 p0346 A79-18057
- BAKER, E. G.**  
Chemical production from waste carbon monoxide:  
Its potential for energy conservation  
[BNWL-2137] 21 p0170 A79-10179
- BAKER, H. S.**  
Predicting the performance of passive solar-heated  
buildings  
21 p0063 A79-13899

BAKER, R. R.

PERSONAL AUTHOR INDEX

- BAKER, R. R.  
Test and development of ceramic combustors,  
stators, nose cones, and rotor tip shrouds  
21 p0049 A79-12821
- BAKER, R. W.  
Wind power potential in the Pacific Northwest  
22 p0244 A79-21334
- BAKER, T. H.  
Integrating wave power into the electricity supply  
system  
21 p0152 A79-18117
- BAKER, W. R.  
Life cycle costing of energy systems  
21 p0072 A79-14683
- BALACHANDRA, J.  
Spectral selective properties of black chrome and  
nickel electrodeposited coatings for solar  
absorber  
21 p0127 A79-17383
- BALAKRISHNAN, A. R.  
Use of monolithic structures for the short term  
storage of solar energy  
21 p0121 A79-17327
- Optimization studies on black chrome  
electroplating variables for solar selective  
surfaces  
22 p0317 A79-31407
- Studies on the effect of bed aspect ratios and  
pressure drop on flow distribution in rock bed  
storage systems for solar energy applications  
22 p0317 A79-31409
- BALCOMB, J. D.  
Passive solar heating of buildings  
[LA-UR-77-1162]  
21 p0090 A79-15859
- Passive solar heating of buildings  
22 p0275 A79-25928
- Solar heating and cooling performance of the Los  
Alamos National Security and Resources Study  
Center  
22 p0277 A79-25944
- BALIGA, B. V.  
Liquid solar collector  
21 p0133 A79-17433
- BALL, G. L., III  
Form-stable, crystalline polymer pellets for  
thermal energy storage  
21 p0013 A79-10107
- BALL, J. T.  
A numerical solar radiation model based on  
standard meteorological observations  
21 p0041 A79-11871
- Computation of IR sky temperature and comparison  
with surface temperature  
21 p0042 A79-11875
- BALLANTYNE, W. E.  
Preliminary environmental assessment of biomass  
conversion to synthetic fuels  
[PB-289775/9]  
22 p0365 A79-21224
- BALU, K.  
Utilisation of solid waste  
22 p0304 A79-30204
- BALZHISER, R. E.  
EPA program conference report: Coal cleaning, an  
option for increased coal utilization  
[PB-288223/1]  
22 p0344 A79-17378
- BANKIEWITZ, P.  
Electronic components in solar technology  
21 p0056 A79-13629
- BANNERT, K.  
Investigation of the heat transfer in cylindrical  
receiver configurations with inner tubes  
[ASME PAPER 79-GT-64]  
22 p0306 A79-30532
- BANDER, T. J.  
Measured air flow rates through microorifices and  
flow prediction capability  
[PB-286868/5]  
21 p0217 A79-14344
- BANE, R.  
Coal liquefaction support studies. Task 1: Heat  
of reaction of hydrogen with coal slurries.  
Task 2: Heat transfer coefficient  
[ANL/CEN/FE-77-5]  
21 p0216 A79-14242
- BANERJEE, A.  
Sprayed CdS thin films for CdS/Cu<sub>2</sub>S heterojunction  
solar cells  
21 p0123 A79-17346
- Stoichiometric Cu<sub>2</sub>S thin films for solar cells  
21 p0123 A79-17349

- BANNEROT, R.  
Thermal storage and heat transfer in solar energy  
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1978  
22 p0280 A79-26201
- BANNEROT, R. B.  
Optimal geometries for one- and two-faced  
symmetric side-wall booster mirrors  
21 p0149 A79-18019
- BANY, J.  
Analysis of a direct coupling d.c. motor and a  
photovoltaic converter  
21 p0046 A79-12272
- BARAKAT, S. A.  
NRC solar monitoring program  
22 p0318 A79-31419
- BARANOV, G. A.  
Calculation and design of liquid-metal MHD  
induction machines  
22 p0286 A79-27302
- BARAONA, C. R.  
Status of wraparound contact solar cells and arrays  
21 p0001 A79-10014
- BARBER, R. E.  
Solar Rankine engines - Examples and projected costs  
[ASME PAPER 79-SOL-3]  
22 p0307 A79-30541
- BARBERI, F.  
Shallow magmatic reservoirs as heat source of  
geothermal systems - Preliminary interpretation  
of data available for the Neapolitan active  
volcanic areas  
21 p0075 A79-14727
- BARDAKOV, V. B.  
Relaxation of a fast ion beam in a tokamak plasma  
22 p0324 A79-31760
- Calculation of the Q factor for a two-component  
tokamak  
22 p0324 A79-31763
- BARLEY, C. D.  
Optimal sizing of solar collectors by the method  
of relative areas  
21 p0066 A79-14263
- BARNES, C.  
Recent results from the PLT tokamak  
21 p0069 A79-14453
- BARNETT, A. E.  
The design and fabrication of CdS/Cu<sub>2</sub>S cells of  
8.5-percent conversion efficiency  
22 p0300 A79-29428
- Low cost thin-film CdS-based solar cells progress  
and promise  
[ASME PAPER 79-SOL-15]  
22 p0309 A79-30549
- BARNEY, D. L.  
Thermal management of the lithium/metal sulfide  
electric vehicle  
[SAE PAPER 790161]  
22 p0315 A79-31366
- BARNSTABLE, A. G.  
Allowable costs for alternative domestic heating  
systems using utility supplied electricity for  
backup or charging energy  
22 p0319 A79-31428
- BARRETT, W. J.  
Evaluation of electrostatic precipitator during  
SRC combustion tests  
[PB-285864/5]  
21 p0223 A79-14618
- BARRINGER, A. R.  
Surtrace - An airborne geochemical system  
22 p0255 A79-22557
- BARRY, J. D.  
Frequency doubling of a solar pumped Nd:YAG laser  
21 p0044 A79-12062
- BARTEL, L. C.  
Instrumentation development for in situ coal  
gasification  
21 p0006 A79-10053
- BARTHELEMY, R. R.  
Military needs for orbital power  
21 p0169 A79-10127
- BARTKE, T. C.  
Comparison of shale oils from different sources  
produced by controlled-state retort  
21 p0005 A79-10047
- BARTLETT, D.  
Heating and confinement in the CLEO stellarator  
21 p0070 A79-14459

- BARTLETT, R.**  
Novel duplex vapor electrochemical method for silicon solar cells  
[NASA-CR-158039] 21 p0218 N79-14537
- BARTOK, W.**  
Combustion modifications for the control of air pollutant emissions from coal fired utility boilers  
[ASME PAPER 78-WA/APC-7] 21 p0158 A79-19738
- BARTOL, J. A.**  
Environmentally induced cracking of natural gas and liquid pipelines. Volume 2: Appendices A and B  
[PB-282924/0] 21 p0181 N79-11446  
Environmentally induced cracking of natural gas and liquid pipelines. Volume 1: Technical report  
[PB-282923/2] 21 p0181 N79-11447
- BARTOLI, B.**  
Selective covers for natural cooling devices 22 p0272 A79-25522
- BARVE, K. H.**  
Solar ammonia-water absorption system for cold storage application 21 p0143 A79-17521
- BARVENIK, P. W.**  
ERDA's oceanographic program for the mid-Atlantic coastal region  
[BNL-24016] 21 p0192 N79-11641  
Assessment of the solid waste impact of the National Energy Plan  
[BNL-50708] 21 p0213 N79-13572
- BASHILOV, V. A.**  
Effect of the properties of the working body on the selection of the temperature of the surface of the electrodes of the channel of an MHD generator 21 p0167 A79-20419
- BASHKATOV, V. A.**  
Dynamic characteristics of a free-piston diesel engine combined with a MHD generator 22 p0258 A79-23137
- BASILE, B. P.**  
Environmental effects of offshore oil production 22 p0336 N79-16389
- BASON, P.**  
Solar energy use in Denmark /56 deg N/ and higher latitudes in Scandinavia 21 p0128 A79-17393
- BASU, D.**  
Health effects associated with diesel exhaust emissions, literature review and evaluation  
[PB-289817/9] 22 p0364 N79-20727
- BASU, P.**  
Role of the diode exponential factor in CdS solar cells 21 p0123 A79-17348
- BASU, S. P.**  
Simulation study of natural convection heat transfer in inclined air layers with application to solar energy collection 21 p0129 A79-17401
- BATEMAN, G.**  
MHD instabilities 22 p0259 A79-23599
- BATES, J. L.**  
Development, characterization and evaluation of materials for open cycle MHD  
[PNL-2004-9] 22 p0361 N79-20504  
Development, characterization and evaluation of materials for open cycle MHD  
[PNL-2004-8] 22 p0369 N79-21557
- BATEY, J.**  
Brookhaven National Laboratory burner-boiler/furnace efficiency test project. Annual fuel use and efficiency reference manual: hydronic equipment  
[BNL-50816] 21 p0210 N79-13538
- BAYSTELLI, J.-P.**  
Solar thermal conversion installations in the medium power range - The Thek project 22 p0254 A79-22269
- BAUER, W.**  
Alpha transport and blistering in tokamaks 22 p0253 A79-22243
- BAUGHN, J. W.**  
Effects of low solar input and amount of storage on thermosyphon hot water system performance 22 p0267 A79-24312
- BAUM, B.**  
Encapsulation task of the low-cost silicon solar array project. Investigation of test methods, material properties, and processes for solar cell encapsulants  
[NASA-CR-157939] 21 p0195 N79-12544
- BAUM, I. V.**  
Large-aperture radiant solar energy concentrators 21 p0135 A79-17452
- BAUM, I. A. M.**  
Experimental study of the characteristics of heat and mass transfer in a two-component low-temperature heat pipe 22 p0246 A79-21585
- BAUM, P. E.**  
Energy utilization survey pamphlet for buildings.  
[AD-A062930] 22 p0371 N79-21624
- BAUM, V. A.**  
The attainable efficiency of the solar thermoelectric generators 21 p0140 A79-17496
- BAWA, S. C.**  
Design and fabrication of silicon solar cells for concentrated light 21 p0124 A79-17352
- BAYLISS, D.**  
Electric vehicles - Can they be fitted into urban Britain 22 p0301 A79-29093
- BAYTOS, W. C.**  
Preliminary environmental assessment of biomass conversion to synthetic fuels  
[PB-289775/9] 22 p0365 N79-21224
- BAZAROV, B. A.**  
The feasibility of constructing a photoelectric unit utilizing effluent heat 21 p0125 A79-17358
- BAZAROV, KH.**  
The feasibility of constructing a photoelectric unit utilizing effluent heat 21 p0125 A79-17358
- BAZQUES, E. O.**  
Stochastic simulation experiments on solar air conditioning systems 21 p0138 A79-17474  
System performance predictions for solar cooling using regional stochastic weather models 22 p0264 A79-23781
- BEARD, J. T.**  
Annual collection and storage of solar energy for the heating of buildings 21 p0131 A79-17415  
Earth-conducted heat losses from thermal storage systems 22 p0281 A79-26208
- BEARD, S. G.**  
Instrumentation for in situ coal gasification. II - Thermal and gas sampling diagnostic techniques 21 p0032 A79-10520
- BEARD, T. H.**  
Colorado's oil-shale resource for vertical modified in-situ processes 21 p0005 A79-10046
- BEARDSWORTH, E.**  
Energy needs, uses, and resources in developing countries  
[BNL-50784] 21 p0185 N79-11500
- BEASON, F. L.**  
Solar assisted heat pump study for heating of military facilities  
[AD-A058626] 21 p0206 N79-13506
- BEATON, M. S.**  
Corrosion and deposits in MHD generator systems 21 p0081 A79-14935
- BEATTIE, A. G.**  
Acoustic emissions during hydride formation 22 p0249 A79-21691
- BECKER, P. E.**  
Design of superconducting magnets for full-scale MHD generators 21 p0084 A79-15306  
Combustion of pulverized coal in high temperature preheated air  
[AIAA PAPER 79-0298] 21 p0158 A79-19654
- BECKER, M.**  
Development and application of techniques to evaluate cogeneration impacts 22 p0303 A79-29795

- BECKHAM, L. W.**  
Instrumentation for in situ coal gasification. IV  
- Seismic and acoustic techniques for remote monitoring  
22 p0304 A79-29974
- BECKHAM, R. F.**  
Gasification Combined Cycle Test Facility at  
Pekin, Illinois  
21 p0145 A79-17632
- BECKHAM, W. A.**  
Simulations of the performance of open cycle  
desiccant systems using solar energy  
21 p0066 A79-14262  
Design of active solar heating systems  
21 p0090 A79-15860  
A general design method for closed-loop solar  
energy systems  
22 p0295 A79-28359
- BECUS, G. A.**  
Coupled heat and organic wastes stream pollution  
21 p0086 A79-15602
- BEDAIR, S. H.**  
A two-junction cascade solar-cell structure  
22 p0256 A79-22856
- BEEKLEY, D. C.**  
Long-term average performance of the Sunpak  
evacuated-tube collector  
21 p0089 A79-15854  
Analysis and experimental tests of a  
high-performance evacuated tubular collector  
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Research and development needs to merge  
environmental and energy objectives  
[GPO-23-254]  
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- BEHRETT, H.**  
On the mechanism of the electrocatalytic oxygen  
reduction with particular regard to metal chelates  
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- BEILIS, I. I.**  
Mechanism of erosion of metal electrodes of the  
channel of a MHD generator  
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- BEIN, J.**  
Development, testing and evaluation of MHD  
materials and component designs  
[PB-2248-19]  
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- BEJAN, A.**  
Two thermodynamic optima in the design of sensible  
heat units for energy storage  
21 p0150 A79-18091
- BEKEY, I.**  
High efficiency low cost solar cell power  
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Statement of Ivan Bekey, Director of Advanced  
Mission Studies, Aerospace Corporation  
21 p0224 A79-15107
- BEKINSINSKI, R.**  
Some aspects of aircraft jet engine fuels  
21 p0035 A79-11368
- BELDING, J. A.**  
Conservation as an energy source  
21 p0077 A79-14769  
The impact of alternate energy resources on the  
future supply of electric power  
[IEEE PAPER P 78 672-8]  
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- BELL, D. H.**  
Solar energy for industrial process steam  
22 p0267 A79-24315
- BELL, J. H.**  
Off-peak electrical backup experience in the  
Meadowvale Solar Experiment  
22 p0318 A79-31421  
Measured and predicted performance of solar  
domestic water heaters  
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- BELL, H. G.**  
Measurements of plasma rotation in tokamak IT-3  
22 p0252 A79-22238
- BELL, W. F.**  
Development of advanced fuel cell system  
[NASA-CR-159443]  
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- BELLER, H.**  
Energy systems studies program  
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- BELTZER, H.**  
Real-time, continuous measurement of automotive  
sulfuric acid emissions  
21 p0156 A79-19359
- BEN-DAVID, S.**  
The economic performance of passive solar heating  
- A preliminary analysis  
[AIAA PAPER 78-1761]  
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Impacts of the National Energy Plan on solar  
economics  
[CONF-771203-6]  
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- BENARD, C.**  
Theoretical and experimental analysis of a latent  
heat storage system  
21 p0121 A79-17323  
On the use of grating or mesh selective filters to  
increase the efficiency of flat plate solar  
collectors  
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Prediction of the behavior of a solar storage  
system by means of recurrent stochastic models  
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- BENHAM, W. L.**  
Preliminary design and analysis of a total energy  
system for Massachusetts Institute of Technology  
[AD-A057289]  
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- BENJAMIN, R. F.**  
Prepulse damage to targets and alignment  
verification  
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- BENNETT, C. O.**  
Evaluation of commercial catalysts for the  
Fischer-Tropsch reaction  
22 p0272 A79-25124
- BENNETT, L. H.**  
Materials for fuel cells  
[PB-285360/4]  
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- BENNETT, O. L.**  
Potential agricultural uses of fluidized bed  
combustion waste  
21 p0064 A79-14108
- BENNINGTON, G.**  
System for projecting the utilization of renewable  
resources. SPURR methodology  
[ERHQ/2322-77/4]  
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- BENOIT, J.**  
The propulsion of vehicles by a flywheel  
21 p0031 A79-10452
- BENTE, P. F., JR.**  
New concepts in waste utilization and biomass  
21 p0095 A79-15915
- BERCAV, R. W.**  
Preliminary summary of the ETF conceptual studies  
[NASA-TN-78999]  
21 p0183 A79-11478
- BERCHOWITZ, D. H.**  
A computer and experimental simulation of Stirling  
cycle machines  
21 p0023 A79-10192
- BERDAHL, C. H.**  
Calibration standards and field instruments for  
the precision measurement of insolation  
21 p0076 A79-14765  
Thermal energy transformer  
[NASA-CASE-NPO-14058-1]  
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- BEREZNETSKII, M. S.**  
Properties of the plasma ions and the particle  
lifetime in ohmic heating in the L-2 stellarator  
22 p0244 A79-21428
- BERGER, B. J.**  
An overview of the STOR hydrogen energy program  
22 p0289 A79-27655
- BERGESON, L.**  
Sail power for the world's cargo ships  
22 p0305 A79-30374
- BERGHMAN, J. A.**  
Performance of a hydraulic air compressor for use  
in Compressed Air Energy Storage power systems  
22 p0280 A79-26191
- BERGHAN, P. D.**  
Ionizing seed  
21 p0106 A79-16490
- BERGSTROM, S.**  
Salinity power station at the Swedish west-coast -  
Possibilities and energy-price for a 200 MW-plant  
21 p0077 A79-14772

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Conceptual design of thermal energy storage systems for near term electric utility applications. Volume 1: Screening of concepts [NASA-CR-159411-VOL-1] 21 p0205 N79-13496
- BERKOWITZ, D. A.  
Preliminary controller evaluation for the HERC/CTIU using a mathematical process model 21 p0008 A79-10073
- BERLAD, A. L.  
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- BERMAN, S.  
Urbanism and energy in developing regions [LBL-7808] 21 p0189 N79-11540
- BERNAL, G., E.  
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- BERNDORFER, K.  
Development of small solar power plants for rural areas in India 21 p0141 A79-17502
- BERNER, W. E.  
Behavior of nonmetallic materials in shale oil derived jet fuels and in high aromatic and high sulfur petroleum fuels [AD-A060322] 21 p0226 N79-15203
- BERNHEISEL, J. F.  
Energy from urban waste 21 p0096 A79-15917
- BERRY, G. L.  
Energy and input-output analysis 21 p0115 A79-17223
- BERRY, H. R.  
Sensor selection and placement in the National Solar Data Program 21 p0089 A79-15844
- BERRY, R. S.  
Resource analysis: Water and energy as linked resources [PB-288046/6] 22 p0349 N79-18463
- BERT, C. W.  
On vibration of a thick flexible ring rotating at high speed 22 p0235 A79-20511
- BERTA, H.  
Energy from sea waves - System optimization by diffraction theory 22 p0288 A79-27390
- BERTOLINI, E.  
The 'PICTOR 1' design - A minimum size tokamak experimental reactor 21 p0078 A79-14782
- BERTMAN, R. W.  
The first year of solar collector testing at Ontario Research 22 p0322 A79-31450
- BESANT, R. W.  
The Saskatchewan Conservation House - Some preliminary performance results 22 p0318 A79-31417
- Energy management through energy conservation in buildings 22 p0320 A79-31431
- Passive solar heating - Results from two Saskatchewan residences 22 p0322 A79-31444
- BEST, R. J.  
Pressure measurements on wind tunnel models of the Aylesbury experimental house 22 p0300 A79-29372
- BETLEJ, K.  
Bituminous coal extraction in terms of electron-donor and -acceptor interactions in the solvent/coal system 22 p0283 A79-26469
- BEYELER, J. A.  
Instrumentation for in situ coal gasification. II - Thermal and gas sampling diagnostic techniques 21 p0032 A79-10520
- BEZDEK, R. H.  
Costs and impacts of financial incentives for solar energy systems 21 p0119 A79-17296
- Economic feasibility of solar water and space heating 22 p0292 A79-27899
- BHATTAGAR, V. P.  
Magneto-acoustic resonance heating in the ion-cyclotron frequency domain 22 p0271 A79-24866
- BHATTACHARYA, S. C.  
Investigation on the feasibility of using a two-phase thermosyphon for solar storage, space heating and cooking 21 p0121 A79-17330
- BHAVSAR, V. C.  
A reflector concentrator modified sterling engine unit and an aqua-ammonia absorber gas turbine unit for farm power needs 21 p0142 A79-17509
- BHOLAGIR, A. P.  
Saur vidyut kosh - The solar cell 21 p0126 A79-17371
- BHUSHAN, B.  
Honeycomb type flat plate collectors - Experiments leading to drinking straw 21 p0132 A79-17424
- BIALUSCHESKI, H.  
Gasification of coal with high-temperature reactor heat - Investigations concerning the market and the economics 22 p0264 A79-23828
- BIANCA, J. D.  
Flow modeling of an atmospheric pressure, entrained-type coal gasifier 22 p0280 A79-26188
- BIANCARDI, F. R.  
Analysis and design of an 18-ton solar-powered heating and cooling system 21 p0019 A79-10156
- BIEDERMAN, H.  
Alternative forms of energy transmission from OTEC plants 21 p0141 A79-17505
- Feasibility study of transporting offshore OTEC-produced energy to shore by thermal media. Project 8980 [DSE/2426-19] 21 p0174 N79-10535
- BIENERT, W.  
Liquid metal heat pipes for the central solar receiver 21 p0014 A79-10114
- BIENSTOCK, D.  
Protection of the biosphere 21 p0105 A79-16483
- BIERENBAUM, H. S.  
Identification of cost effective energy conservation measures 21 p0099 A79-16133
- BIERNAN, W. J.  
Candidate chemical systems for air cooled, solar powered, absorption air conditioner design. Part 2: Solid absorbents, high latent heat refrigerants [SAR/1587-2] 21 p0211 N79-13544
- BIPANO, W.  
NASA Lewis Research Center photovoltaic application experiments [AIAA PAPER 78-1768] 21 p0061 A79-13867
- BIPANO, W. J.  
Photovoltaic power systems for rural areas of developing countries 22 p0278 A79-26131
- Photovoltaic power systems for rural areas of developing countries [NASA-TN-79097] 21 p0229 N79-15411
- BILGEN, B.  
Solar heating and ventilating by natural means 21 p0103 A79-16458
- Solar hydrogen production at high temperatures 21 p0104 A79-16464
- On the optimisation of Trombe wall solar collectors [ASME PAPER 78-WA/SOL-13] 21 p0163 A79-19845
- Solar power plants 22 p0318 A79-31416
- Solar heating and ventilation using the modified Trombe wall system 22 p0320 A79-31435
- Statistical analysis of solar radiation data in Montreal for solar energy utilization 22 p0322 A79-31452



- A hybrid wind turbine suitable for developing regions  
22 p0323 A79-31455
- BILGER, G.**  
Improvement of efficiency and stability by copper-treatment and front contacting of Cu/x/S-CdS solar cells  
21 p0123 A79-17345
- A pilot line for the production of large area Cu/x/S-CdS solar cells  
21 p0124 A79-17351
- BILLINGS, R. E.**  
Progress report on hydrogen production and utilization for community and automotive power  
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- BILLMAN, K. W.**  
Enhanced solar energy options using earth-orbiting mirrors  
21 p0019 A79-10162
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- BINDER, H.**  
On the mechanism of the electrocatalytic oxygen reduction with particular regard to metal chelates  
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- BINGHAM, C. E.**  
Design optimization for solar array of multiple collector types  
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- Estimating hourly solar radiation for one-axis tracking focusing collectors  
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- BINIK, J. P.**  
Research and development needs to merge environmental and energy objectives  
[GPO-23-254]  
22 p0342 N79-17339
- BIRCHENROUGH, A. G.**  
Design and operating experience on the U.S. Department of Energy Experimental Mod-C 100 kW Wind Turbine  
21 p0028 A79-10234
- BIRINGER, K. L.**  
Combined photovoltaic thermal collector testing [SAND-78-1191C]  
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- BIRK, J. R.**  
Superbatteries - A progress report  
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- BIRKELAND, J.**  
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- BIRNBERGER, B.**  
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- Solar water heating [BMPT-FB-T-77-42]  
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- BIRZVALK, IU. A.**  
Equations of a conduction MHD ejector  
22 p0298 A79-29289
- BISSET, J. B.**  
Design study on solar energy systems for commercial buildings  
22 p0320 A79-31433
- BISSON, C. L.**  
Alpha transport and blistering in tokamaks  
22 p0253 A79-22243
- BITIURIN, V. A.**  
Effect of force field nonuniformity on flow in an MHD channel  
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- Comparison of results of calculation of flow in an MHD generator with experimental data obtained on the U-25 device  
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- BITTNER, J. D.**  
Role of aromatics in soot formation  
21 p0053 A79-12988
- BIVINS, R. L.**  
Mining earth's heat - Hot dry rock geothermal energy  
22 p0258 A79-23280
- BLACH, W.**  
Optimization of a novel hydrostatic drive performance using hybrid computing technique  
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- BLACK, D. L.**  
Conceptual design of the Fort Hood Solar Total Energy-Large Scale Experiment  
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- Development, testing and evaluation of MHD materials and component designs  
[FE-2248-19]  
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- BLACKSHEAR, P. L., JR.**  
Biomass utilization in Minnesota  
[PB-282531/3]  
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- BLACKWOOD, T. R.**  
Source assessment: Water pollutants from coal storage areas  
[PB-285420/6]  
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- Source assessment: Open mining of coal. State of the Art  
[PB-288497/1]  
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- BLAGA, A.**  
Use of plastics in solar energy applications  
21 p0067 A79-14268
- BLAIR, P. D.**  
Modeling energy and power requirements of electric vehicles  
21 p0153 A79-18465
- BLANDINO, A.**  
Energy from sea waves - System optimization by diffraction theory  
22 p0288 A79-27390
- BLANKENSHIP, G. L.**  
Modelling energy storage systems for electric utility applications Preliminary considerations  
21 p0081 A79-14960
- BLASER, R. F.**  
Quasi-equilibrium Air Standard heat balanced cycle analysis  
21 p0028 A79-10232
- BLAY, D.**  
The French CNRS 1 MW solar power plant  
21 p0141 A79-17498
- BLAZEK, C.**  
Alternative forms of energy transmission from OTEC plants  
21 p0141 A79-17505
- BLAZOWSKI, W. S.**  
Future fuels in gas turbine engines  
21 p0051 A79-12979
- Evaluation of future jet fuel combustion characteristics  
[AD-A060218]  
21 p0216 N79-14231
- BLECHER, W. A.**  
Modeling the champagne effect in compressed air energy storage  
22 p0280 A79-26190
- BLEILER, K. W.**  
Coal desulfurization using microwave energy  
[PB-285880/1]  
21 p0216 N79-14243
- BLINK, J.**  
Electric power from laser fusion - The HYLIFE concept  
21 p0030 A79-10249
- Civilian applications of laser fusion  
[UCRL-52349]  
21 p0195 N79-12439
- BLOCKER, W.**  
High efficiency low cost solar cell power  
21 p0048 A79-12471
- BLODGETT, J. E.**  
Research and development needs to merge environmental and energy objectives  
[GPO-23-254]  
22 p0342 N79-17339
- BLOOMFIELD, H. S.**  
Benefits of solar/fossil hybrid gas turbine systems  
[ASME PAPER 79-GT-38]  
22 p0309 A79-30554
- Benefits of solar/fossil hybrid gas turbine systems  
[NASA-TN-79083]  
21 p0229 N79-15410

- BLOSS, W. H.  
Improvement of efficiency and stability by copper-treatment and front contacting of Cu/x/S-CdS solar cells 21 p0123 A79-17345  
A pilot line for the production of large area Cu/x/S-CdS solar cells 21 p0124 A79-17351
- BLUM, S.  
Report of the 4th CCHS (Committee on the Challenges of Modern Society) Solar Energy Pilot Study Meeting [PB-289492/1] 22 p0372 N79-21631
- BLUMER, K.  
Assessment of the solid waste impact of the National Energy Plan [BBL-50708] 21 p0213 N79-13572
- BOARDMAN, C. B.  
An assessment of subsurface salt water disposal experience on the Texas and Louisiana Gulf coast for application to disposal of salt water from geopressured geothermal wells [WVO/1531-2] 22 p0366 N79-21523
- BOAS, R. J.  
Army energy plan [AD-A057987] 21 p0197 N79-12562
- BOBKLDIJK, C.  
Toroidal high-beta systems 21 p0070 A79-14462
- BOBROV, V. L.  
Effect of the properties of the working body on the selection of the temperature of the surface of the electrodes of the channel of an MHD generator 21 p0167 A79-20419
- BOBROVSKII, G. A.  
Progress in tokamak experimental research in the Soviet Union 21 p0069 A79-14455
- BOBROVSKIY, S. A.  
Dependence of the pour point of diesel fuels on the properties of the initial components [NASA-TN-75424] 22 p0364 N79-21217
- BOCKRIS, J. OH.  
Hydrogen production in a solar-hydrogen economy 21 p0037 A79-11796
- BODE, K. H.  
Gasification of coal with high-temperature reactor heat. - Investigations concerning the market and the economics 22 p0264 A79-23828
- BODENHTEL, J.  
Application of LANDSAT data and digital image processing [E79-10102] 22 p0339 N79-17291
- BODY, I.  
Prediction of the behavior of a solar storage system by means of recurrent stochastic models 22 p0258 A79-23295
- BOEHR, K. W.  
Progress and trends in the development of terrestrial photoelectric conversion 21 p0056 A79-13635  
The photovoltaic effect in CdS/Cu2S solar cells 21 p0091 A79-15871  
The photovoltaic effects in CdS/Cu2S solar cells 21 p0123 A79-17347  
Solar retrofitting of existing residence with almost zero delta TE system 21 p0139 A79-17485
- BOEHM, H.  
Development of a 1 kW fuel cell aggregate with acid electrolyte 21 p0148 A79-17994
- BOEHM, R.  
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- BOENIG, H. J.  
30-MJ superconducting magnetic energy storage /SMES/ unit for stabilizing an electric transmission system 22 p0237 A79-20555
- BOES, E. C.  
Status of the DOE photovoltaic concentrator technology development project [SAND-78-0948C] 21 p0176 N79-10550
- BOGART, S. L.  
Fusion-Fission Energy Systems 21 p0017 A79-10144
- BOGGS, W. H.  
Identification of cost effective energy conservation measures 21 p0099 A79-16133
- BOGNER, S.  
Effort of the Jet Propulsion Laboratory 22 p0370 N79-21575
- BOHABA, R. C.  
Explanation for low-efficiency Cu2O Schottky-barrier solar cells 22 p0256 A79-22859
- BOL, K.  
Recent results from the PLT tokamak 21 p0069 A79-14453
- BOLAN, P.  
Venture analysis case study for on-site fuel cell energy systems [PCB-0783-VOL-1] 22 p0361 N79-20505
- BOLDWIN, B.  
Performance predictions of a LiBr absorption air conditioner utilizing solar energy 21 p0139 A79-17482
- BOLEZ, C. A.  
Production and use of low and medium Btu gas 21 p0095 A79-15912
- BOLING, M. L.  
Review of theories for predicting n2 in glasses and crystals 21 p0083 A79-15139
- BOLOVNER, T. M.  
Spectral characteristics of photoconverters with nonuniform defect distribution in the base 21 p0053 A79-13289
- BOLT, J. B. D. B.  
The Netherlands experimental vertical axis wind turbine 21 p0114 A79-17120
- BOLTON, J. B.  
Solar fuels 21 p0149 A79-18009
- BOHAR, S. H., JR.  
Preliminary results from the Georgia Tech 400 kWth Solar Thermal Test Facility 21 p0141 A79-17499
- BONKAMP, D. H.  
Open-cycle MHD development 22 p0289 A79-27659
- BONACQUISTI, J.  
An improved solar panel and method for fabricating the same [NASA-CASE-NPO-14490-1] 22 p0348 N79-18445
- BONDI, H.  
Energy research and development - A U.K. view 22 p0325 A79-31910
- BONDIETTI, E. A.  
Nonproliferation Alternative Systems Assessment Program (NASAP): Preliminary environmental assessment of thorium/uranium fuel cycle systems [ORNL/TN-6069] 21 p0192 N79-11570
- BONELLO, A. B.  
Alternative energy sources for Federal Aviation Administration facilities [AD-A058681] 21 p0196 N79-12555
- BONHOMME, R.  
Efficiency of sugar cane and cowpea as solar energy converters 21 p0125 A79-17368
- BONI, A. A.  
Mathematical models of direct initiation of unconfined gas phase detonations [AIAA PAPER 79-0289] 21 p0157 A79-19649
- BONINO, P.  
Silver selenate and silver tellurate as positive materials for lithium primary power sources 22 p0245 A79-21484
- BONOLI, P. T.  
Wave reflection from the lower hybrid surface - A toroidal effect 22 p0255 A79-22427
- BOODMAN, W. S.  
Fluid-bed carbonization/desulfurization of Illinois coal by the Clean Coke Process - PDU studies 21 p0045 A79-12121

- BOODY, F. P.  
Progress in nuclear-pumped lasers 21 p0110 A79-16627
- BOON, R. W.  
High-current power leads for tokamak fusion reactor superconducting magnets. 21 p0085 A79-15318  
Design criteria for multilayer superconductive magnets 22 p0236 A79-20536
- BOOTH, D. C.  
Chemical vapor deposited amorphous silicon for use in photothermal conversion 22 p0294 A79-28149
- BOOTH, L. A.  
Commercial applications of thermionic conversion using a fusion reactor energy source - A preliminary assessment 21 p0026 A79-10219
- BORDEN, R.  
Design and operating experience of the cryogenic system of the U.S. SCMS as incorporated into the bypass loop of the U-25 MHD generator facility 22 p0235 A79-20532
- BORDINA, M. M.  
Study of photoelectric characteristics of photocells made from high-resistivity silicon 22 p0296 A79-28666
- BORDOLOI, K. C.  
Analysis of optical behavior and collector performance of a solar concentrator 21 p0107 A79-16545
- BORGATTI, C.  
Electrostatic precipitation tests with fuel oil ash 22 p0296 A79-28390
- BORGESSE, D.  
Design study of a thermohydraulic loop for the conversion of geothermal energy /low enthalpy/ into electricity 21 p0076 A79-14741
- BORGHARD, W. G.  
Evaluation of commercial catalysts for the Fischer-Tropsch reaction 22 p0272 A79-25124
- BORGHI, C. A.  
Experimental investigation on the discharge structure in a noble gas MHD generator [TH-78-E-79] 22 p0350 A79-18758
- BORNATICI, E.  
Electrons of high perpendicular energy in the low-density regime of tokamaks 22 p0270 A79-24852  
Wave propagation and absorption near the electron-cyclotron layer in the 'THOR' device 22 p0271 A79-24867
- BORRERO, J. M.  
Grain-boundary edge passivation of GaAs films by selective anodization 21 p0154 A79-18487  
Diffusion length measurements in Schottky barrier GaAs solar cells 22 p0281 A79-26243  
Solar power satellite rectenna design study: Directional receiving elements and parallel-series combining analysis [NASA-CR-151866] 22 p0330 A79-16039
- BORTNIKOV, A. V.  
Effect of the magnetic configuration of the poloidal diverter on the plasma in the T-12 finger-ring tokamak 22 p0244 A79-21429
- BORTON, D.  
A cost effective total energy system using a faceted mirror sunlight concentrator and high intensity solar cells 21 p0135 A79-17446
- BOS, P. B.  
Perspectives on utility central station photovoltaic applications 21 p0041 A79-11873
- BOSSEL, U.  
German Solar Energy Forum, 1st, Hamburg, West Germany, September 26-28, 1977, Proceedings. Volume 2 21 p0055 A79-13619
- BOTHAM, R. A.  
Form-stable, crystalline polymer pellets for thermal energy storage 21 p0013 A79-10107
- BOTTS, T. E.  
The LASH /laser-ash/ particulate fragmentation removal concept for coal fired turbine power plants 21 p0009 A79-10078
- BOUNDI, R. A.  
Advanced composites - Future space applications 21 p0086 A79-15509
- BOUREAU, G.  
High temperature thermodynamics of the solid solutions of hydrogen and deuterium in palladium and in the Pd/0.9/Ag/0.1/ alloy 22 p0249 A79-21689
- BOUREQUE, R. F.  
A calculation of linear magnetic liner fusion reactor performance 21 p0018 A79-10153  
Parametric requirements for noncircular Tokamak commercial fusion plants [GA-A-14876] 21 p0214 A79-13871  
Parametric requirements for noncircular Tokamak commercial fusion plants [GA-A-14946] 21 p0214 A79-13872
- BOURQUIN, J. P.  
Solar power plants 22 p0318 A79-31416
- BOURRET, B.  
Solar houses in Blagnac /Blagnac, Haute-Garonne, France/ 22 p0276 A79-25937
- BOWEN, A.  
Integrated solar building systems 21 p0103 A79-16460  
Prospects for ambient energy and cogeneration utilization in urban and regional planning 21 p0104 A79-16465  
Inexpensive solar energy utilization in human settlements 21 p0104 A79-16470
- BOWEN, B. E.  
On the depletion of ambient ozone by a rural coal-fired power plant near Portage, Wisconsin 21 p0082 A79-15052
- BOWEN, S. W.  
Enhanced solar energy options using earth-orbiting mirrors 21 p0019 A79-10162  
Orbiting mirrors for terrestrial energy supply 21 p0108 A79-16605  
Space reflector technology and its system implications [AIAA PAPER 79-0545] 22 p0273 A79-25852
- BOWEN, T. C., JR.  
US Army/Environmental Projection Agency re-refined engine oil program [AD-A056806] 21 p0171 A79-10216
- BOWMAN, C. T.  
Alternative hydrocarbon fuels: Combustion and chemical kinetics; SQUID Workshop, Loyola College, Columbia, Md., September 7-9, 1977, Technical Papers 21 p0051 A79-12977  
Alternative hydrocarbon fuels: Combustion and chemical kinetics [AD-A061050] 22 p0338 A79-17011
- BOWMAN, E. G.  
Thermochemical production of hydrogen from water [LA-UR-78-652] 21 p0180 A79-11236
- BOWMAN, R. C., JR.  
NMR studies of hydrogen relaxation and diffusion in TiFeB/x/ and TiFe/1-y/Er/y/H/x/ 22 p0248 A79-21684
- BOWREY, R. G.  
Energy storage using the reversible oxidation of barium oxide 22 p0242 A79-21169
- BOY-HARCOTTE, J.-L.  
Medium capacity heliothermal power stations 21 p0142 A79-17507  
Medium-power /100-1000 kWe/ solar power plants using distributed collectors 22 p0269 A79-24622
- BOYCE, H. P.  
The external combustion steam injected gas turbine for cogeneration 21 p0012 A79-10100
- BOYD, D.  
Recent results from the PLT tokamak 21 p0069 A79-14453

- BOYD, D. A.  
The contribution of plasma dielectric properties to the cyclotron radiation spectrum from a tokamak plasma  
22 p0312 A79-31183
- BOYD, W. K.  
Chloride corrosion and its inhibition in refuse firing  
21 p0080 A79-14930  
Corrosion and deposits from combustion of solid waste. VI - Processed refuse as a supplementary fuel in a stoker-fired boiler  
[ASME PAPER 78-WA/FU-4] 21 p0160 A79-19788
- BREADFORD, R.  
Support services for electric vehicles  
22 p0301 A79-29492
- BRADLEY, J.  
Heating and confinement in the CLEO stellarator  
21 p0070 A79-14459
- BRADLEY, J. O.  
Design optimization for solar array of multiple collector types  
21 p0071 A79-14677  
Estimating hourly solar radiation for one-axis tracking focusing collectors  
21 p0071 A79-14678
- BRADLEY, T. G.  
Bipolar lithium/iron disulfide cells  
21 p0010 A79-10090
- BRAINARD, J. P.  
Energy situation in the Mid-Atlantic region  
[BNL-50703] 21 p0188 W79-11528
- BRANLEY, T. T.  
Recent advances in thermochemical energy storage and transport  
21 p0012 A79-10104  
Thermochemical energy storage and transport program  
[SAND-78-8056] 21 p0221 W79-14570
- BRAUNHUEHL, H. J.  
Economic evaluation and optimization of solar heating systems  
21 p0118 A79-17293
- BRANDHORST, H. W., JR.  
Back wall solar cell  
[NASA-CASE-LEW-12236-2] 21 p0217 W79-14528
- BRANDSTETTER, A.  
High reliability contacts for miniature thermoelectric converters  
21 p0027 A79-10228  
Solar furnace type high power density thermoelectric generator  
21 p0027 A79-10229
- BRANDVOLD, G. E.  
The USA 5MW solar thermal test facility  
21 p0135 A79-17449  
Vertical axis wind turbine status  
21 p0143 A79-17516  
Solar irrigation program status  
21 p0143 A79-17520
- BRANTLEY, L. W.  
Selling solar energy as a cash crop  
21 p0049 A79-12725
- BRAREN, R.  
Development of compact heat exchangers for Ocean Thermal Energy Conversion /OTEC/ systems  
[ASME PAPER 78-WA/HT-34] 21 p0161 A79-19815
- BRAU, R.  
Recent results from the PLT tokamak  
21 p0069 A79-14453
- BRAUNSTEIN, J.  
Migrational polarization in high-current density molten salt electrochemical devices  
21 p0039 A79-11811  
Steady-state composition profiles in mixed molten salt electrochemical devices. II - Molten carbonate fuel cell analogs  
22 p0305 A79-30333
- BRAUNSTEIN, L. A.  
Wind energy - The long road to commercialization  
22 p0269 A79-24612
- BRENN, B. P.  
Reducing inefficiency and emissions of large steam generators in the United States  
21 p0114 A79-17075
- BRENNAN, J. J.  
Engineering and economic analysis of waste to energy systems  
[PB-285797/7] 21 p0224 W79-14946
- BREITER, H. W.  
Preparation and ionic conductivity of H3O<sup>+</sup>/beta alumina  
21 p0040 A79-11821
- BRENNAN, P. J.  
Copper/water axially-grooved heat pipes for RTG applications  
21 p0023 A79-10188
- BRENNENCKE, P.  
Hydrogen production by conventional and modified water electrolysis  
21 p0059 A79-13659  
Generation of electrical energy from hydrogen and oxygen by means of fuel cells  
21 p0059 A79-13662
- BRETZ, N.  
Recent results from the PLT tokamak  
21 p0069 A79-14453
- BREUER, K.  
Safety requirements for solar heating systems - Practical considerations  
21 p0056 A79-13634
- BREWNOW, M. H.  
Effect of the magnetic configuration of the poloidal diverter on the plasma in the T-12 finger-ring tokamak  
22 p0244 A79-21429
- BREWER, D. E.  
Measurement and control techniques in geothermal power plants  
[TREE-1312] 22 p0362 W79-20508
- BREWER, G. D.  
Some environmental and safety aspects of using hydrogen as a fuel  
22 p0238 A79-20774  
Cryohydrogen-fuel for tomorrow's commercial aircraft  
22 p0289 A79-27656
- BREWER, G. E.  
Economic evaluation of the ATC/Wellman incandescent two-stage low Btu coal gas producer  
21 p0146 A79-17640
- BRIGGS, D. C.  
Intelsat V solar array design and development summary  
21 p0002 A79-10018
- BRIGGS, T.  
Air quality assessment of particulate emissions from diesel-powered vehicles  
[PB-286172/2] 21 p0223 W79-14641
- BRINK, D. F.  
Solar energy for industrial process steam  
22 p0267 A79-24315
- BRINKWORTH, B. J.  
Asymptotic behaviour as a guide to the long term performance of solar water heating systems  
21 p0041 A79-11872
- BRIODY, K.  
A low energy scenario for the United States - 1975-2050  
21 p0147 A79-17649
- BRITT, E. J.  
Thermionic power plant design point selection - The economic impact  
21 p0025 A79-10214  
Thermionics and its application to the SPS  
21 p0109 A79-16616  
The TELEC - A plasma type of direct energy converter  
21 p0110 A79-16629  
Power coupling alternatives for the NEP thermionic power system  
[NASA-CR-158372] 22 p0367 W79-21547
- BROADBENT, S.  
Photovoltaic concentrating array  
21 p0021 A79-10172
- BROCK, R.  
Coal liquefaction support studies. Task 1: Heat of reaction of hydrogen with coal slurries.  
Task 2: Heat transfer coefficient  
[ANL/CEN/FE-77-5] 21 p0216 W79-14242
- BROCKHANE, R.  
The potential of fusion reactors as process heat source  
22 p0284 A79-26624
- BRODERSEN, H.  
Intelsat V solar array design and development summary  
21 p0002 A79-10018

- BROGAN, T. R.  
Subsonic diffusers for MHD generators  
22 p0279 A79-26185
- BRONCA, G.  
Superconducting magnets - Present status and problems  
22 p0311 A79-31009
- BROWNER, G.  
SLPX - Superconducting Long-Pulse Tokamak Experiment  
22 p0237 A79-20557
- BROWNE, G.  
A study of positive electrode materials for batteries operating in a halide-aluminate medium  
22 p0245 A79-21480  
Hydrogen electrochemical storage by substituted LaNi5 compounds  
22 p0251 A79-21711
- BROWSON, J. C.  
30-MJ superconducting magnetic energy storage /SMES/ unit for stabilizing an electric transmission system  
22 p0237 A79-20555
- BROOKS, G. R.  
Orbiting Solar Observatory /OSO-8/ solar panel design and in-orbit performance  
21 p0001 A79-10017
- BROONHALL, E.  
Solar energy retrofit system for an older-type building - The Williamstown Museum project  
22 p0320 A79-31434
- BROSCHK, J.  
Dornier/RWE solar house in Essen, FRG  
22 p0276 A79-25933  
Solar water heating [BMFT-PB-T-77-42]  
22 p0349 A79-18457
- BROSSIER, P.  
Non-thermal emission at the plasma frequency  
22 p0270 A79-24854
- BROUSSARD, P. H., JR.  
An approach to automated longwall mining [AIAA PAPER 79-0532]  
22 p0274 A79-25871
- BROWN, B. T.  
Advanced industrial gas turbine cooling and high pressure compressor technology  
21 p0004 A79-10041
- BROWN, C. K.  
P.E.I. solar assisted domestic water heat project  
22 p0323 A79-31458
- BROWN, C. T.  
Preliminary results from the Georgia Tech 400 kWth Solar Thermal Test Facility  
21 p0141 A79-17499
- BROWN, G. L.  
Results of a tilt-tilt low profile heliostat test program  
21 p0076 A79-14761
- BROWN, K. C.  
Options for solar thermal conversion  
21 p0043 A79-11969
- BROWN, K. T.  
Nuclear power today and tomorrow  
22 p0340 A79-17317
- BROWN, N. D.  
Low NOx combustion concepts for advanced power generation systems firing low-Btu gas [PB-282983/6]  
21 p0178 A79-10610
- BROWN, R. A.  
Tests of various coals, coal-oil mixtures and refuse derived fuels in an experimental test facility [ASME PAPER 78-WA/APC-12]  
21 p0158 A79-19741  
Nickel-zinc battery for aircraft and missile applications [AD-A059295]  
21 p0220 A79-14561
- BROWN, S.  
Organic geochemical studies on kerogen precursors in recently deposited algal mats and oozes  
21 p0031 A79-10419
- BROWN, T. D.  
Modification of electrostatic precipitator performance by use of fly-ash conditioning agents [ASME PAPER 78-WA/APC-3]  
21 p0158 A79-19736
- BROWN, T. W.  
Powerplant integration - The application of current experience to future developments [ASME PAPER 78-GT-113]  
21 p0032 A79-10788
- BRUCK, J. M.  
Particulate control for coal-fired industrial boilers  
21 p0065 A79-14123
- BRUCK, M.  
Solar energy activities in Austria  
21 p0117 A79-17283  
Proposal for a representation of the quasisteady-state performance of flat-plate collectors [ASSA-SE-B21/77]  
22 p0349 A79-18461
- BRUMMER, S. B.  
The secondary lithium electrode in non-aqueous electrolytes - Some problems, some solutions  
21 p0041 A79-11838  
A lithium/dissolved sulfur battery with an organic electrolyte  
22 p0305 A79-30332
- BRUNO, R.  
What and where - Solar active systems or energy conservation in buildings  
22 p0275 A79-25927  
Solar heating, cooling and hot water production - A critical look at CCMS installations  
22 p0275 A79-25931  
The Philips experimental house - A system's performance study  
22 p0277 A79-25941
- BRUSATI, M.  
Recent results from the PLT tokamak  
21 p0069 A79-14453
- BRYANT, W. A.  
Iron-air batteries for electric vehicles  
21 p0011 A79-10094
- BYERS, R. W.  
Ash deposits and corrosion due to impurities in combustion gases; Proceedings of the International Conference, New England College, Henniker, N.H., June 26-July 1, 1977  
21 p0080 A79-14926
- BRZUSKIEWICZ, J.  
Suitable optical materials for solar collector applications  
22 p0239 A79-20823
- BUBE, R. H.  
Photovoltaic effects in II-VI heterojunctions  
21 p0042 A79-11967
- BUCHANAN, C. H.  
Energy storage for tokamak reactor cycles  
21 p0111 A79-16727
- BUCHHEIM, R.  
Influences on exhaust emissions from automotive gas turbines [ASME PAPER 78-GT-85]  
22 p0255 A79-22338
- BUCHNER, H.  
The hydrogen/hydride energy concept  
22 p0252 A79-21717
- BUCKINGHAM, J. P.  
Conversion of a standard single cylinder I.C. engine into a 'gamma' configuration air charged Stirling engine  
21 p0024 A79-10202
- BUCKIUS, R. O.  
Diffuse solar radiation on a horizontal surface for a clear sky  
22 p0242 A79-21167  
Direct solar transmittance for a clear sky  
22 p0296 A79-28361
- BUCKLEY, M. A.  
Practical considerations for 'capturing the sun'  
21 p0089 A79-15853
- BUCKLEY, S. B.  
A Thermic Controller for a thermic diode solar panel [ASME PAPER 78-WA/SOL-9]  
21 p0163 A79-19841  
Cooling applications of thermic diode panels [ASME PAPER 78-WA/SOL-10]  
21 p0163 A79-19842
- BUDGER, H. P.  
New approaches for the appropriate use of solar energy in northern climates  
22 p0319 A79-31424
- BUDINIR, J.  
Active heat exchange system development for latent heat thermal energy storage [NASA-CR-159479]  
22 p0368 A79-21554
- BUCHHEL, J. H.  
Test and development of ceramic combustors, stators, nose cones, and rotor tip shrouds  
21 p0049 A79-12821

PERSONAL AUTHOR INDEX

BUTLER, R.

- BURDENBENDER, U.  
The need for closed service areas in a supply economy based on line networks 21 p0168 A79-20447
- BUEHLER, E.  
High efficiency solar cells based on indium phosphide 21 p0042 A79-11968
- BUEHROSTRO, J.  
The direct reduction of sulfur dioxide 21 p0065 A79-14124
- BUGOS, B. J.  
Assessment of economic factors affecting the satellite power system. Volume 2: The systems implications of rectenna siting issues [NASA-CR-161186] 22 p0368 N79-21552
- BUILTJES, P. J. H.  
Calculation of wake effects in wind turbine parks 21 p0045 A79-12241
- BURKEEV, E. N.  
Selection of thermal operating regimes for fuel cell reactor-condenser systems 21 p0165 A79-20342
- BULZAH, D. L.  
Correlations of catalytic combustor performance parameters 21 p0081 A79-14956
- BUNK, W.  
Ceramic materials for vehicular gas turbine applications 21 p0165 A79-20085
- BUNSHAH, R. P.  
Metallurgical coatings 1978; Proceedings of the Fifth International Conference, San Francisco, Calif., April 3-7, 1978. Volumes 1 & 2 22 p0327 A79-31951
- BUNTZEN, R.  
Civilian applications of laser fusion [UCRL-52349] 21 p0195 N79-12439
- BUNYAGIDJ, C.  
The preparation of some novel electrolytes: Synthesis of partially fluorinated alkane sulfonic acids as potential fuel cell electrolytes [AD-A056278] 21 p0184 N79-11483
- BUNNICORE, A. J.  
Energy and the environment; Proceedings of the Fifth National Conference, Cincinnati, Ohio, November 1-3, 1977 21 p0063 A79-14106
- BURENKO, O.  
Dynamics and feedback control of ISX tokamak 21 p0107 A79-16559
- BURGESS, E. L.  
Application of the superposition principle to solar-cell analysis 22 p0300 A79-29426  
Photovoltaic concentrator system technology and applications experiments [ASME PAPER 79-SOL-9] 22 p0308 A79-30544  
Effect of solar cell parameter variation on array power output [SAND-78-0917C] 21 p0188 N79-11527  
Development of high-efficiency P(+) - N-N(+) back-surface-field silicon solar cells [SAND-78-1156C] 21 p0188 N79-11529
- BURGGRAP, S. P.  
Energy: The new economic development wildcard [PB-282494/4] 21 p0177 N79-10564
- BURKE, J. D.  
Energy conversion at a lunar polar site 21 p0108 A79-16607
- BURKHARD, D. G.  
Comparison of the solar concentrating properties of truncated hexagonal, pyramidal and circular cones 21 p0043 A79-11974
- BURKHART, J. A.  
Design study of superconducting magnets for a combustion magnetohydrodynamic /MHD/ generator 21 p0084 A79-15305
- BURNETT, J. C.  
Aging behavior of crude shale oil [AD-A062420] 22 p0357 N79-20272
- BURNS, D.  
Heat transfer in phosphoric acid fuel cell stacks 21 p0010 A79-10091
- BURNS, D. J.  
Fracture research in Canada 21 p0144 A79-17530
- BURSELL, B.  
Utility fuel cells for biomass fuel 21 p0016 A79-10131
- BURTON, E. L.  
Compact fusion reactors using controlled imploding liners 21 p0018 A79-10151
- BURWELL, E. L.  
Status of the DOE underground coal conversion program 21 p0005 A79-10052
- BUSCH, C. P.  
Tests of various coals, coal-oil mixtures and refuse derived fuels in an experimental test facility [ASME PAPER 78-WA/APC-12] 21 p0158 A79-19741
- BUSCH, G.  
Hydrides of rare earth-nickel compounds - Structure and formation enthalpies 22 p0250 A79-21697  
The plateau pressure of RE Ni5 and RE Co5 hydrides 22 p0250 A79-21698  
Hydrogen storage in FeTi - Surface segregation and its catalytic effect on hydrogenation and structural studies by means of neutron diffraction 22 p0312 A79-31156
- BUSCHOW, E. H. J.  
Model predictions for the stability of ternary metallic hydrides 21 p0038 A79-11802  
Hydrogen absorption in rare earth intermetallic compounds 22 p0249 A79-21693
- BUSH, L. B.  
Future solar total energy markets for the U.S. industrial sector [AIAA PAPER 78-1773] 21 p0062 A79-13870
- BUSS, B.  
Support services for electric vehicles 22 p0301 A79-29492
- BUSSAC, H. W.  
MHD stability of Spheromak 22 p0313 A79-31189
- BUT, D. A.  
Optimization of a diagonal MHD channel 22 p0247 A79-21628
- BUTCHER, S. G.  
Coal preparation design for export markets, with particular reference to South African and Canadian coals 22 p0340 N79-17318
- BUTERA, F.  
The relationship between diffuse and total solar radiation in computer simulation of solar energy systems 21 p0119 A79-17304
- BUTLER, B. L.  
Optical evaluation techniques for reflecting solar concentrators 21 p0043 A79-11971
- BUTLER, C. P.  
Total solar irradiance at Table Mtn, California 1926-77 21 p0067 A79-14269
- BUTLER, C. S.  
Further studies of fuels from alternate sources: Fire extinguishment experiments with JP-5 jet turbine fuel derived from shale [AD-A058586] 21 p0201 N79-13182
- BUTLER, E. W.  
Geothermal energy in Imperial County, California - Environmental, socio-economic, demographic, and public opinion research conclusions and policy recommendations 22 p0265 A79-24046
- BUTLER, H. A.  
Role of semiconductor properties in photoelectrolysis 21 p0037 A79-11780
- BUTLER, W. G.  
Wind power potential in the Pacific Northwest 22 p0244 A79-21334
- BUTLER, R.  
Coal gasification studies. I - Single stage complete gasification of coal using water as the hydrogen source 22 p0283 A79-26466

- Coal gasification studies. II - Reduction in the presence of  $I_2$  with  $H_2$ , and  $H_2O/+$  metal, at pressures up to 3500 p.s.i. and temperatures of 600 C in all quartz reactors  
22 p0283 A79-26468
- Coal gasification studies. III - Reduction in the presence of some metal iodides and iron halides  
22 p0299 A79-29314
- BUTT, S. H.  
An overview of solar markets  
21 p0092 A79-15884
- BUTZE, H. P.  
Parametric performance of a turbojet engine combustor using jet A and A diesel fuel [NASA-TM-79089]  
22 p0357 N79-20114
- BUZZELLI, E. S.  
Iron-air batteries for electric vehicles  
21 p0011 A79-10094
- BYERS, D. J.  
Electricity - An indigenous transport fuel  
22 p0292 A79-27898
- BYLINSKY, G.  
Space will be the next big construction site  
22 p0268 A79-24450
- BYRON, R. A.  
Particulate and sulfur oxide control options for conventional coal combustion  
21 p0092 A79-15883
- BYSTRYL, A. I.  
Stability of combustion in the combustion chamber of an MHD generator  
21 p0049 A79-12691
- Turbulence of a combustion product plasma in an MHD channel  
22 p0246 A79-21538

## C

- CADIEUX, S.  
Control system for solar hot water system  
22 p0321 A79-31442
- CADOFF, L. E.  
Development, testing and evaluation of MHD materials and component designs [FE-2248-19]  
22 p0369 N79-21558
- CAHEN, D.  
Polycrystalline CdSe-based photo-electrochemical cells  
21 p0037 A79-11785
- Photoacoustic determination of photovoltaic energy conversion efficiency  
21 p0154 A79-18503
- CAHILL, D. F.  
Preliminary assessment of the environmental impacts of the Satellite Power System /SPS/  
22 p0326 A79-31922
- CAHILL, T. P.  
Wind-turbine-generator rotor-blade concepts with low-cost potential  
22 p0240 A79-20828
- CAIRELLI, J. E.  
Ceramic applications in the advanced Stirling automotive engine  
21 p0051 A79-12851
- CAIRNS, E. J.  
Electric vehicles challenge battery technology  
21 p0093 A79-15892
- CALOGERAS, J. E.  
Storage systems for solar thermal power  
21 p0013 A79-10108
- CALVIN, H.  
Organic geochemical studies on kerogen precursors in recently deposited algal mats and oozes  
21 p0031 A79-10419
- Petroleum plantations  
21 p0095 A79-15910
- Synthetic chloroplasts  
22 p0262 A79-23721
- CALVO, R.  
Development, testing and evaluation of MHD materials and component designs [FE-2248-19]  
22 p0369 N79-21558
- CANDEN, J. T.  
Automotive engines - A viable alternative for aircraft  
21 p0047 A79-12379
- CANERON, A. E.  
Net energy analysis of five energy systems [ORAU/IEA(R)-77-12]  
21 p0174 N79-10534

- CAMPBELL, B. C.  
Progress report on hydrogen production and utilization for community and automotive power  
21 p0016 A79-10132
- Hydrogen economy - An alternative  
21 p0096 A79-15925
- CAMPBELL, D. O.  
Proliferation-resistant nuclear fuel cycles [ORNL/TM-6392]  
21 p0214 N79-13849
- CAMPBELL, J. H.  
Oil shale retorting - A correlation of selected infrared absorbance bands with process heating rates and oil yield  
22 p0304 A79-29975
- CAMPBELL, J. S.  
The Campbell Chinese Type Windmill  
21 p0142 A79-17510
- CAMPBELL, R. B.  
Phase two of the array, automated assembly task for the low cost solar array project [NASA-CR-158359]  
22 p0359 N79-20484
- CAMPBELL, R. O.  
Prefabricated caissons for tidal power development  
21 p0152 A79-18113
- CANNON, T.  
Coal liquefaction support studies. Task 1: Heat of reaction of hydrogen with coal slurries. Task 2: Heat transfer coefficient [ANL/CEN/FE-77-5]  
21 p0216 N79-14242
- CARUTO, R. S.  
Comparative evaluation of distributed-collector solar thermal electric power plants  
21 p0021 A79-10173
- CARDEN, P. O.  
The efficiencies of thermochemical energy transfer  
21 p0054 A79-13575
- Energy storage efficiency for the ammonia/hydrogen-nitrogen thermochemical energy transfer system  
22 p0261 A79-23718
- Screening reversible reactions for thermochemical energy transfer  
22 p0285 A79-26823
- CARDER, B.  
Pulsed power supplied for large laser systems [UCRL-80113]  
21 p0217 N79-14377
- CARBART, S. C.  
Economic impacts of a transition to higher oil prices [BNL-50871]  
22 p0364 N79-20927
- The Brookhaven buildings energy conservation optimization model [BNL-50828]  
22 p0370 N79-21564
- CARIDES, J. H.  
Low voltage behavior of lithium/metal dichalcogenide topochemical cells  
22 p0286 A79-26995
- CARLI, G.  
Heat pipe central solar receiver gas turbine plant  
21 p0022 A79-10178
- CARLING, R. W.  
Specific heat variations in oil energy storage media and their economic implications [SAND-78-8672]  
21 p0189 N79-11537
- CARLSON, A.  
USAP terrestrial energy study. Volume 3, part 1: Summary data display [AD-A061071]  
22 p0342 N79-17341
- CARLSON, G. A.  
Mirror fusion reactors  
21 p0018 A79-10148
- CARLSON, L. W.  
Steam generator and turbomachines  
21 p0106 A79-16489
- HYCSOS - A system for evaluation of hydrides as chemical heat pumps  
22 p0252 A79-21716
- CARLSON, H. G.  
Second-generation integrated coal gasification/combined-cycle power systems [ASME PAPER 78-GT-14]  
21 p0032 A79-10778
- CARLSON, T. C. G.  
Energy analyses applied to ocean thermal energy conversion and an offshore wind power system  
22 p0353 N79-19442
- CARRERAS, B.  
Non-linear numerical algorithms for studying tearing modes  
22 p0257 A79-22981

- CARRIE, J.**  
Energy policy of the European Economic Community  
22 p0282 A79-26403
- CARRIGAN, B.**  
Optical coatings for solar cells and solar collectors. Citations from the HTIS data base [HTIS/PS-78/1341/3] 22 p0350 A79-18465  
Optical coatings for solar cells and solar collectors. Citations from the Engineering index data base [HTIS/PS-78/1342/1] 22 p0350 A79-18466
- CARROLL, J. E.**  
Source emissions factors for refuse derived fuels  
21 p0082 A79-15084
- CARROLL, W. L.**  
Geographical variation in the heating and cooling requirements of a typical single-family house, and correlation of these requirements to degree days [PB-289204/0] 22 p0355 A79-19467
- CARRUTHERS, E.**  
Fusion reactor problems  
21 p0071 A79-14468
- CARSCALLEN, W. E.**  
NRC solar monitoring program  
22 p0318 A79-31419  
First year performance data and lessons learned in the NRC 14 house solar demonstration program  
22 p0323 A79-31453
- CARSON, J. L.**  
Low head power generation with bulb turbines  
21 p0074 A79-14705
- CARTER, C.**  
Mathematical modelling of passive solar systems  
22 p0321 A79-31441
- CARTER, G. C.**  
NMR studies of hydrogen relaxation and diffusion in  $\text{TiFe}/x/$  and  $\text{TiFe}/1-y/\text{Mn}/y/\text{H}/x/$   
22 p0248 A79-21684
- CARTER, W. J.**  
Permeability enhancement using explosive techniques  
21 p0005 A79-10048
- CARVER, G. E.**  
Chemical vapor deposited molybdenum films for use in photothermal conversion  
22 p0294 A79-28148
- CASAMAJOR, A. B.**  
Design guide for shallow solar ponds [UCRL-52385] 21 p0185 A79-11497
- CASSEL, D. E.**  
Principles of solar cooling and heating  
21 p0103 A79-16457  
Application of solar cooling for a school building in subtropics  
21 p0103 A79-16461  
Use of solar energy to heat anaerobic digesters. Part 1: Technical and economic feasibility study. Part 2: Economic feasibility throughout the United States [PB-286940/2] 21 p0231 A79-15440
- CASWELL, W.**  
Measured and modeled passive performance in Montana  
22 p0322 A79-31445
- CATALDO, R. L.**  
Response of lead-acid batteries to chopper-controlled discharge  
21 p0011 A79-10097
- CATCHPOLE, B. G.**  
Tests of Wisconsin S12D engine running on natural gas with addition of carbon dioxide [AD-A058486] 22 p0339 A79-17230
- CATHERINO, R. A.**  
100MWh zinc-chlorine peak-shaving battery plants  
21 p0011 A79-10096
- CATHODIAU, R.**  
Rule of fuel management  
21 p0155 A79-18521
- CATTANEO, L. E.**  
Provisional flat plate solar collector testing procedures [PB-283721/9] 21 p0198 A79-12571
- CAVAGNARO, D. E.**  
Nitrogen oxide air pollution. Volume 2, part 1: Control technology. A bibliography with abstracts [HTIS/PS-78/0971/8] 21 p0199 A79-12591  
Nitrogen oxide air pollution. Part 3: Atmospheric chemistry. A bibliography with abstracts [HTIS/PS-78/0973/4] 21 p0199 A79-12593
- Synthetic fuels: Methane. Citations from the Engineering Index data base [HTIS/PS-79/0030/1] 22 p0365 A79-21223
- CAVALLARO, J. A.**  
An overview of coal preparation  
21 p0044 A79-12115
- CAVARD, D.**  
Energy balances as a means for the evaluation of solar energy in developing countries  
21 p0118 A79-17290
- CAWOOD, W. E.**  
Low-temperature application of solar energy in South Africa  
22 p0340 A79-17324
- CELATA, C. E.**  
The contribution of plasma dielectric properties to the cyclotron radiation spectrum from a tokamak plasma  
22 p0312 A79-31183
- CERINI, D. J.**  
Demonstration of a rotary separator for two-phase brine and steam flows [TID-28519] 22 p0365 A79-21309
- CHA, J. E.**  
Some experimental investigations on solar space heating in Korea  
21 p0138 A79-17470
- CHABBAN, E.**  
Solar heating and ventilation using the modified Trombe wall system  
22 p0320 A79-31435
- CHABRE, Y.**  
NMR studies of hydrogen relaxation and diffusion in  $\text{TiFe}/x/$  and  $\text{TiFe}/1-y/\text{Mn}/y/\text{H}/x/$   
22 p0248 A79-21684
- CHAI, V. W.**  
The updated algorithm of the Energy Consumption Program (ECP): A computer model simulating heating and cooling energy loads in buildings  
22 p0351 A79-19059
- CHAKRABORTY, D.**  
Simulation study of natural convection heat transfer in inclined air layers with application to solar energy collection  
21 p0129 A79-17401
- CHAMBERLAIN, T. W.**  
Performance characteristics of automotive engines in the United States. First series: Report no. 15: 1975 Dodge Colt 98 CID (1.6 liters), 2V [PB-286075/7] 21 p0226 A79-15305  
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Performance characteristics of automotive engines in the United States. First series, report no. 17: 1975 Buick 455 CID (7.5 liters), 4V [PB-286298/5] 21 p0227 A79-15312  
Performance characteristics of automotive engines in the United States. First series, report no. 20: 1975 Chevrolet 350 CID (5.7 liters) with dresser variable-area venturi system [PB-286301/7] 21 p0228 A79-15315
- CHAN, B. C.**  
Heat exchangers for Ocean Thermal Energy Conversion plants  
21 p0142 A79-17506
- CHANDLER, W. T.**  
Hydrogen embrittlement and its control in hydrogen-fueled engine systems  
22 p0366 A79-21429
- CHANDRA, K.**  
Economics of fuel gas from coal: An update including the British Gas Corporation's slagging gasifier [EPRI-AP-782] 21 p0180 A79-11238
- CHANDRA, S.**  
Dependence of solar radiation availability on atmospheric turbidity  
21 p0119 A79-17308



- CHANDRA, S.  
Development of small solar power plants for rural areas in India  
21 p0141 A79-17502
- CHANDRA, S. K.  
Development of 1 kW vertical axis wind generator  
21 p0142 A79-17511
- CHANDRASHEKAR, N.  
Collector and storage efficiencies in solar heating systems  
22 p0320 A79-31432  
WATSUN - A simulation program for solar-assisted heating systems  
22 p0321 A79-31439
- CHANG, G.  
Laboratory evaluation of a composite flywheel energy storage system  
21 p0013 A79-10110
- CHANG, G. C.  
SIMWEST - A simulation model for wind energy storage systems  
21 p0029 A79-10241
- CHAPMAN, J. B.  
Economic optimization of the coal-fired MHD Steam Power Plant  
21 p0016 A79-10134  
Controlling NO<sub>x</sub> from a coal-fired MHD process  
21 p0017 A79-10139  
Design studies and trade-off analyses for a superconducting magnet/MHD power generator system  
21 p0017 A79-10142
- CHAPMAN, P. K.  
Health maintenance and health surveillance considerations for an SPS space construction base community  
[AAS PAPER 78-176]  
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Assessment of economic factors affecting the satellite power system. Volume 2: The systems implications of rectenna siting issues  
[NASA-CR-161186]  
22 p0368 N79-21552
- CHAPPELL, T. I.  
V-groove multijunction solar cells  
22 p0353 N79-19445
- CHARAN, S.  
Series resistance effects in GaAl/As/GaAs concentrator solar cells  
22 p0273 A79-25745
- CHARLESWORTH, G.  
The energy and resource implications associated with the widespread use of electric vehicles  
22 p0301 A79-29489
- CHARLIER, R. H.  
Tidal power plants - Sites, history and geographical distribution  
21 p0150 A79-18102
- CHARTERS, W. W. S.  
Convective effects in 'slat collectors'  
21 p0129 A79-17400  
Design problems of air source solar boosted heat pumps  
21 p0138 A79-17472
- CHARTIER, P.  
Efficiency of sugar cane and cowpea as solar energy converters  
21 p0125 A79-17368
- CHATHAN, G. H.  
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[GPO-35-823]  
21 p0232 N79-15815
- CHATTERJI, D.  
Development of sodium-sulfur batteries for utility application  
[EPRI-EM-683]  
21 p0186 N79-11502
- CHAUBET, P.  
Underground gasification of coal at deep levels - Perspectives and problems  
21 p0156 A79-19401
- CHAVES, E. J.  
Analysis of optical behavior and collector performance of a solar concentrator  
21 p0107 A79-16545
- CHEE, P. C.  
A biologist's manual for the evaluation of impacts of coal-fired power plants on fish, wildlife and their habitats  
[PB-291330/9]  
22 p0373 N79-21679
- CHEESEMAN, I. C.  
The impact of aeronautical sciences on other modes of transport  
22 p0325 A79-31915
- CHEEBERIS, V. T.  
Electromagnetic excitation of a moving conducting piston  
22 p0237 A79-20658  
Electromechanical conversion of energy during the deceleration of a piston in a uniform magnetic field  
22 p0309 A79-30599
- CHEN, B.  
Parameter estimation and validation of a solar assisted heat pump model  
22 p0332 N79-16349
- CHEN, C. W.  
Optical design of a solar collector for the advanced solar thermal electric conversion/process heat program  
[Y/SUB-77/14261]  
21 p0209 N79-13528
- CHEN, J. L. S.  
Optimum dry-cooling sub-systems for a solar air conditioner  
[NASA-TN-79007]  
21 p0183 N79-11477
- CHEN, K. I.  
The effects of wall temperature on light impurities in Alcatraz  
22 p0313 A79-31188
- CHEN, L.  
Theory of dissipative drift instabilities in sheared magnetic fields  
22 p0292 A79-27884
- CHEN, L.-T.  
Gas-cycle solar refrigeration system performance  
21 p0153 A79-18471
- CHEN, T. L. C.  
On vibration of a thick flexible ring rotating at high speed  
22 p0235 A79-20511
- CHEN, W. S.  
Improved semiconductors for photovoltaic solar cells  
[DSE/2459-2]  
21 p0221 N79-14577
- CHEERISE, P.  
Process development for the Westinghouse advanced fluidized-bed coal gasification system  
21 p0006 A79-10058
- CHEERKAS, V. D.  
Vaporization of drops of a melt of potassium carbonate in a medium of combustion products  
21 p0167 A79-20411
- CHEERNOFF, R.  
Large active retrodirective arrays for solar power satellites  
21 p0107 A79-16604
- CHEERNOPEKOV, N. A.  
Cryogenic technology and superconductivity in controlled fusion  
22 p0311 A79-31003
- CHEERINGTON, D. C.  
Solids mixing and fluidization characteristics in a tube filled bed  
21 p0008 A79-10070
- CHEZAEV, N. P.  
Superconductivity in antenna engineering  
22 p0311 A79-31008
- CHETTY, P. R. K.  
Enhanced power generation by optical solar reflectors on geostationary spinners  
22 p0272 A79-25138
- CHI, C.  
Heat transfer in phosphoric acid fuel cell stacks  
21 p0010 A79-10091
- CHIANG, C. W.  
Limitations of solar assisted heat pump systems  
[ASME PAPER 78-WA/SOL-1]  
21 p0162 A79-19834
- CHIANG, S. B.  
Discharge characteristics of a soluble iron-titanium battery system  
22 p0286 A79-26996
- CHIKOVANI, V. V.  
Using H<sub>2</sub>O<sub>4</sub> in a solar gas-turbine plant  
21 p0167 A79-20357
- CHILD, T. H.  
Solar radiation charts  
22 p0263 A79-23763
- CHILENSKAS, A. A.  
Thermal management of the lithium/metal sulfide electric vehicle  
[SAE PAPER 790161]  
22 p0315 A79-31366

- CHIN, J.  
Suppression of vaporization in  
copper-silver-selenide thermoelectric materials  
21 p0027 A79-10224
- CHINNECK, J. W.  
Collector and storage efficiencies in solar  
heating systems  
22 p0320 A79-31432
- CHIRON, G.  
Application of composite materials in the solar  
energy domain  
21 p0034 A79-11195
- CHIU, H. S.  
The advanced thermionic converter with microwave  
power as an auxiliary ionization source  
21 p0153 A79-18470
- CHIU, S.-Y.  
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energy development in the Central United States  
21 p0065 A79-14118
- CHIU, W. S.  
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a heat pump application  
21 p0024 A79-10204
- CHOPRA, I.  
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[NASA-TN-78324]  
21 p0195 N79-12542
- CHOPRA, K. L.  
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solar cells  
21 p0123 A79-17346
- Stoichiometric Cu<sub>2</sub>S thin films for solar cells  
21 p0123 A79-17349
- Transparent conducting coatings for solar cells  
21 p0124 A79-17350
- Selective coatings for solar energy conversion  
21 p0126 A79-17376
- CHORICH, H.  
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California local government  
[PB-288656/2]  
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- CHOW, L. S. H.  
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system  
[ASME PAPER 78-WA/HT-21]  
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- CHRETYBERG, A. H.  
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sodium/beta-alumina/SbCl<sub>3</sub> cells  
22 p0245 A79-21479
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program for load leveling  
[EPRI-EH-751]  
21 p0186 N79-11501
- CHRISTENSEN, D. L.  
Analysis of data user's needs for performance  
evaluation of solar heating and  
cooling systems  
21 p0087 A79-15827
- CHRISTIANSEN, W. H.  
A new concept for solar pumped lasers  
21 p0110 A79-16624
- CHRISTIAN, R. C.  
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for PGD (Flue Gas Desulfurization)  
[PB-289921/9]  
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- CHU, S. S.  
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solar cells  
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solar cells  
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- CHURCHILL, A. V.  
Shale oil - The answer to the jet fuel  
availability question  
[SAE PAPER 781027]  
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- CIGNINI, P.  
On the possibility of using silver salts other  
than Ag<sub>2</sub>CrO<sub>4</sub> in organic lithium cells  
22 p0246 A79-21491
- CLAASSEN, R. S.  
Materials problems in solar, nuclear and storage  
of energy  
21 p0094 A79-15901
- CLARK, B.  
The 25 kW space station  
22 p0371 N79-21604
- CLARK, C. L.  
The cryogenic heat transfer tunnel - A new tool  
for convective research  
22 p0267 A79-24316
- CLARK, D.  
Coal gasification and South Africa  
22 p0340 N79-17321
- CLARK, E. C.  
Sulfuric acid-water - Chemical heat pump/energy  
storage system demonstration  
22 p0281 A79-76209
- CLARK, J. A.  
Determining the terrestrial, incident solar flux  
on an arbitrarily oriented surface using  
available solar/weather data  
21 p0119 A79-17310
- CLARK, R. B.  
The economics of Fundy tidal power  
21 p0152 A79-18112
- CLARK, W.  
An analytical and experimental study of pumped  
solar water heaters  
21 p0128 A79-17389
- CLARKE, J. P.  
Philosophy and physics of predemonstration fusion  
devices  
21 p0078 A79-14783
- Predemonstration fusion devices - Research and  
development needs  
21 p0078 A79-14785
- CLARKE, J. B.  
SLPX - Superconducting Long-Pulse Tokamak Experiment  
22 p0237 A79-20557
- CLARKE, W. H., SR.  
There is a lot of energy in digester gas . . . use  
it  
21 p0035 A79-11448
- CLAUBERG, W.  
On the mechanism of the electrocatalytic oxygen  
reduction with particular regard to metal chelates  
21 p0038 A79-11808
- CLAUDET, G.  
Conceptual design of a superconducting tokamak -  
'TORUS II SUPRA'  
22 p0236 A79-20543
- CLAUSING, A. H.  
The cryogenic heat transfer tunnel - A new tool  
for convective research  
22 p0267 A79-24316
- CLAYTON, R. H.  
Hydrogen enrichment for low-emission jet combustion  
22 p0244 A79-21347
- CLEGG, R. J.  
Wind power site evaluation. I - Wind energy  
potential. II - Data acquisition and processing  
22 p0257 A79-22924
- CLELAND, J. G.  
Pollutants from synthetic fuels production:  
Facility construction and preliminary tests  
[PB-287730/6]  
22 p0339 N79-17027
- CLERMONT, H.  
The potential of fusion reactors as process heat  
source  
22 p0284 A79-26624
- CLEWELL, E. J., III  
Drop formation, evaporation modelling and  
environmental assessment of JP-4 fuel jettisoned  
from aircraft  
[AIAA PAPER 79-0186]  
21 p0157 A79-19585
- CLICE, P. B., JR.  
Estimating heat loads on multistage thermoelectric  
heat pumps  
22 p0260 A79-23614
- CLIFF, W. C.  
Generalized wind characteristics and their effect  
on wind turbine output  
21 p0068 A79-14294
- Wind direction change criteria for wind turbine  
design  
[PHL-2531]  
22 p0361 N79-20506
- CLIFFORD, P.  
An assessment of mercury emissions from fossil  
fueled power plants  
[PB-285227/5]  
21 p0213 N79-13592
- CLOSE, D. J.  
Simulations of the performance of open cycle  
desiccant systems using solar energy  
21 p0066 A79-14262

- CLOUD, T. J., JR.  
Texas lignite: Environmental planning opportunities  
[PB-286870/1] 21 p0231 N79-15438
- COAD, W. J.  
Quantification of energy resource consumption  
21 p0073 A79-14701
- COBBLE, M. H.  
Verification of wedge concentration using a helium  
neon laser 21 p0098 A79-16104  
Some effects of leg surface heat losses on the  
performance of a p-n type thermoelectric generator  
22 p0260 A79-23616  
Efficiency of a series of thermoelectric  
generators in a solar wedge concentrator 22 p0260 A79-23618  
Analysis of a Cassegrain solar furnace  
22 p0293 A79-28147
- COENSGEN, P. H.  
The mirror machine program in the USA  
21 p0070 A79-14461
- COETTAUX, H.  
The French CNRS 1 MW solar power plant  
21 p0141 A79-17498  
Thermal energy storage 22 p0310 A79-31000
- COHEN, B. H.  
NaOH-based high temperature heat-of-fusion thermal  
energy storage device 21 p0012 A79-10106  
Phase change thermal storage for a solar total  
energy system 21 p0120 A79-17321  
Development of a phase-change thermal storage  
system using modified anhydrous sodium hydroxide  
for solar electric power generation  
[NASA-CR-159465] 22 p0354 N79-19454
- COHEN, J.  
Test procedures for the determination of the gross  
caloric value of refuse and refuse-derived-fuels  
by oxygen bomb calorimetry: Summary of the 1977  
fiscal year results  
[PB-290160/1] 22 p0364 N79-21167
- COHEN, M. I.  
Materials for fuel cells  
[PB-285360/4] 21 p0212 N79-13553
- COHEN, M. J.  
GaAs polymer-semiconductor solar cells  
[SM/x-GaAs] 21 p0154 A79-18504
- COHEN, R.  
Market penetration for OTEC 21 p0094 A79-15903  
An overview of the U.S. OTEC development program  
21 p0100 A79-16247
- COHEN, S.  
Recent results from the PLT tokamak  
21 p0069 A79-14453
- COHEN, A.  
Investigating combustion turbine burner  
performance with coal derived liquids having  
high fuel bound nitrogen  
[ASME PAPER 78-GT-126] 21 p0033 A79-10791  
Water-cooled gas turbine technology development -  
Fuels flexibility  
[ASME PAPER 79-GT-72] 22 p0307 A79-30536
- COHN, D. R.  
Characteristics of  
electron-cyclotron-resonance-heated tokamak  
power reactors 22 p0292 A79-27885
- COLE, D. E.  
The influence of overall equivalence ratio and  
degree of stratification on the fuel consumption  
and emissions of a prechamber, stratified-charge  
engine  
[SAE PAPER 790438] 22 p0315 A79-31375
- COLE, L. T.  
Liquid-fluidized-bed heat exchanger flow  
distribution models  
[ICP-1151] 22 p0369 N79-21559
- COLE, T.  
Research on the sodium heat engine  
21 p0028 A79-10231
- COLEMAN, G. C.  
External single pass to superheat receiver  
[AIAA PAPER 78-1751] 21 p0089 A79-15849
- COLEMAN, L. V.  
Diagnostics of Shiva Nova high-yield thermonuclear  
events 22 p0285 A79-26747
- COLEMAN, M. G.  
Phase 1 of the automated array assembly task of  
the low cost silicon solar array project  
[NASA-CR-158120] 22 p0348 N79-18451
- COLES, D. G.  
Chemical studies of stack fly ash from a  
coal-fired power plant 22 p0309 A79-30595
- COLLARES-PERRERA, M.  
Simple procedure for predicting long term average  
performance of nontracking and of tracking solar  
collectors 21 p0091 A79-15873  
A compound parabolic concentrator for a high  
temperature solar collector requiring only  
twelve tilt adjustments per year 21 p0134 A79-17439  
Compound parabolic concentrators with  
non-evacuated receivers - Prototype performance  
and a larger scale demonstration in a school  
heating system 21 p0134 A79-17440  
High temperature solar collector of optimal  
concentration - Non-focusing lens with secondary  
concentrator 21 p0135 A79-17448
- COLLIER, M. J.  
Heat pump technology for saving energy  
22 p0302 A79-29624
- COLLIER, R. K.  
Solar collectors. II - Recent developments and  
future performance data and economic analysis  
21 p0103 A79-16456
- COLLINS, J. P.  
Industrial wastes to energy 21 p0096 A79-15916
- COLLINS, T.  
Solar energy - Four sites demonstrate potential  
22 p0328 A79-32194
- COLLIS, W.  
Material growth and characterization directed  
toward improving III-V heterojunction solar cells  
[NASA-CR-158476] 22 p0367 N79-21543
- COLONES, J.  
Theoretical and experimental yields of a solar  
heater with flat plate collectors 21 p0134 A79-17437
- COLSTON, B. W.  
Geothermal energy from a utility perspective  
21 p0091 A79-15880
- COLUZZI, B.  
Selective covers for natural cooling devices  
22 p0272 A79-25522
- COLYER, D. B.  
30-MJ superconducting magnetic energy storage  
/SMES/ unit for stabilizing an electric  
transmission system 22 p0237 A79-20555
- COMBS, L. P.  
Coal conversion by flash hydropyrolysis and  
hydrogasification 21 p0006 A79-10055
- CONCANNON, B. T.  
Energy requirements of the rail mode  
[ASME PAPER 78-RT-1] 21 p0150 A79-18085
- CONEYBEAR, J. P.  
The use of lasers for the transmission of power  
21 p0109 A79-16621
- CONN, R. W.  
Space-dependent thermal stability of reacting  
tokamak plasmas 22 p0253 A79-22242
- CONNELL, J. R.  
Wind characteristics program element  
[PNL-2545] 22 p0356 N79-19568
- CONNOR, B. A.  
Modern technology for recovering energy and  
materials from urban wastes - Its applicability  
in developing countries 22 p0295 A79-28183
- CONNOR, T. J.  
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thermal pilot plant  
[AIAA PAPER 78-1752] 21 p0060 A79-13854

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Present status of two R.F. heating schemes -  
I.C.R.H. and L.H.R.H. 21 p0071 A79-14467
- CONSOLLOY, J. W.  
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sodium/beta-alumina/SbCl<sub>3</sub> cells 22 p0245 A79-21479
- CONTOS, G. Y.  
Assessment of coal cleaning technology: An  
evaluation of chemical coal cleaning processes  
[PB-289493/9] 22 p0372 H79-21625
- CONVERSE, A. O.  
Enhancement of intrinsic solar heating  
21 p0140 A79-17494
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21 p0038 A79-11801
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cooling system with flat-plate and evacuated  
tubular collectors - CSU Solar House I  
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collectors in a residential heating and cooling  
system: Colorado State University Solar House 1  
[COO-2577-14] 21 p0206 H79-13507
- COOK, J.  
A passive rock bed - Design, construction, and  
performance 21 p0121 A79-17328  
An earth-wrapped solar greenhouse house  
21 p0140 A79-17493  
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[PB-287071/5] 22 p0336 H79-16437
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[DOT-TSC-PRA-79-7-1-VOL-1] 22 p0370 H79-21563
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unstabilized water-in-fuel emulsions  
[AD-A062751] 22 p0366 H79-21406
- COOPER, J. P.  
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automotive propulsion 21 p0011 A79-10093  
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- COOPER, L.  
Measurement of high-temperature, high-pressure  
processes [PB-284041/1] 21 p0195 H79-12424
- COOPER, P. I.  
Thermal performance testing of flat-plate solar  
collectors 21 p0130 A79-17407
- COPE, H.  
The design and evaluation of a hydraulic-solar  
powered tracking device 21 p0136 A79-17458
- COPPI, B.  
Compact experiments for alpha-particle heating  
21 p0078 A79-14786
- CORBETT, R. J.  
Measured and modeled passive performance in Montana  
22 p0322 A79-31445
- CORBETT, W. E.  
Guidelines for preparing environmental test plans  
for coal gasification plants [PB-286659/8] 21 p0232 H79-15479
- CORCORAN, W. L.  
Performance of solar heating and cooling systems  
used in the national solar heating and cooling  
demonstration program 21 p0139 A79-17478
- CORDIER, A.  
Solar heating using a heat pump and cold collectors  
22 p0254 A79-22268
- CORLEY, T. L.  
The fate of fuel nitrogen - Implications for  
combustor design and operation 21 p0080 A79-14927
- CORNETT, P. B.  
Study of acoustic and microseismic emissions  
associated with a hydraulic fracture 21 p0076 A79-14744
- COROTIS, R. B.  
Run duration analysis of surface wind speeds for  
wind energy application 22 p0287 A79-27345
- COBREIA, R. J.  
Fossil superheating in geothermal steam power plants  
21 p0014 A79-10122
- CORY, J. S.  
Hitinol heat engines for economical conversion of  
low grade thermal density 21 p0027 A79-10230  
Hitinol thermodynamic state surfaces 21 p0045 A79-12264  
Low-grade thermal energy-conversion Joule effect  
heat engines [ASME PAPER 78-ENAS-7] 21 p0048 A79-12556  
Thermoclines: A solar thermal energy resource for  
enhanced hydroelectric power production 22 p0237 A79-20730
- COSTAIN, J. K.  
Evaluation and targeting of geothermal energy  
resources in the southeastern United States  
[VPI-SU-5648-1] 21 p0204 H79-13478
- COSTELLO, D. E.  
Venture analysis of a proposed federal  
photovoltaic eight-year procurement plan  
[ATAA PAPER 78-1766] 21 p0061 A79-13865  
Barriers and incentives to the commercialization  
of solar heating and cooling of buildings 21 p0072 A79-14687
- COSTELLO, R. E.  
Conceptual design and cost estimate 600 MWe coal  
fired fluidized-bed combined cycle power plant  
21 p0008 A79-10068
- COSTELLO, V. A.  
Heat transfer and calorimetric studies of a direct  
contact-latent heat energy storage system 22 p0281 A79-26210
- COSTLEY, A. E.  
Review of results from DITE tokamak 21 p0069 A79-14456
- COSTOGUE, E. B.  
Ultralow-mass solar-array designs for Halley's  
comet rendezvous mission 21 p0020 A79-10169  
Parametric study of two planar high power flexible  
solar array concepts [NASA-CR-157841] 21 p0205 H79-13501
- COTTINGHAM, J. G.  
Heat pump design - Cost effectiveness in the  
collection, storage and distribution of solar  
energy 22 p0313 A79-31316
- COTTINGHAM, P. L.  
Prerrefining true in situ shale oil 21 p0004 A79-10044
- COUCH, H. D.  
The Otto-engine-equivalent vehicle concept  
[NASA-CR-157840] 21 p0203 H79-13370
- COUGHLIN, R. C.  
An analysis of air pollution control costs in N.S.W.  
21 p0115 A79-17228
- COULT, B. B.  
On the dynamics of wave-power devices 22 p0269 A79-24535
- COURT, J. D.  
An analysis of air pollution control costs in N.S.W.  
21 p0115 A79-17228
- COUSINS, W. J.  
A theoretical study of wood gasification processes  
22 p0257 A79-22923
- COVER, P. W.  
Corrosion and deposits from combustion of solid  
waste. VI - Processed refuse as a supplementary  
fuel in a stoker-fired boiler [ASME PAPER 78-WA/PU-4] 21 p0160 A79-19788
- COX, K. E.  
Thermochemical production of hydrogen from water  
[LA-UR-78-652] 21 p0180 H79-11236
- COX, R.  
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Congress, New Delhi, India, January 16-21, 1978.  
Volumes 1, 2 & 3 21 p0116 A79-17276
- COXON, L. K.  
Alternate energy installations on the Jordan  
College Campus 22 p0323 A79-31450

- COYKENDALL, R. D.  
Advances in lower cost phosphoric acid fuel cells  
21 p0010 A79-10092
- CRASTREE, W. L.  
Solar array systems  
21 p0169 N79-10131
- CRAIG, G. T.  
A comparison of solar thermal energy collection  
using fixed and tracking collectors  
22 p0293 A79-28146
- CRAIG, J. I.  
Moderate cost, calculator-based data acquisition  
for solar HVAC systems  
21 p0088 A79-15837
- CRAWFORD, A.  
Solar engines - The thermal wheel and beyond  
21 p0095 A79-15909
- CRAWFORD, A. R.  
Combustion modifications for the control of air  
pollutant emissions from coal fired utility  
boilers  
[ASME PAPER 78-WA/APC-7]  
21 p0158 A79-19738
- CRAWFORD, K.  
Environmental assessment data base for high-Btu  
gasification technology. Volume 1: Technical  
discussion  
[PB-288602/6]  
22 p0350 N79-18487
- Environmental assessment data base for high-Btu  
gasification technology. Volume 2: Appendices  
A, B, and C  
[PB-288603/4]  
22 p0350 N79-18488
- Environmental assessment data base for high-Btu  
gasification technology. Volume 3: Appendices  
D, E, and F  
[PB-288604/2]  
22 p0350 N79-18489
- Applicability of petroleum refinery control  
technologies to coal conversion  
[PB-288630/7]  
22 p0352 N79-19173
- CRAWFORD, L. W.  
Economic optimization of the coal-fired MHD Steam  
Power Plant  
21 p0016 A79-10134
- Corrosion and deposits in MHD generator systems  
21 p0081 A79-14935
- CRAWFORD, R. W.  
Pressurized fluidized-bed combustion/component  
test and integration unit preliminary design  
report  
21 p0008 A79-10076
- CRAWFORD, W. J., III  
Modern engine development test techniques  
21 p0155 A79-18680
- CREPY, G.  
Advanced electrolysis in alkaline solution  
21 p0037 A79-11798
- CRIM, W. H., JR.  
Cogeneration in Europe and the combined cycle gas  
turbine  
22 p0297 A79-28988
- CRIGUI, P.  
Energy balances as a means for the evaluation of  
solar energy in developing countries  
21 p0118 A79-17290
- CRONQUIST, C.  
Potential producibility and recovery of natural  
gas from geopressed aquifers of the Cenozoic  
sediments of the Gulf Coast Basin  
[FE-2025-3]  
21 p0192 N79-11607
- CROUTHANEL, M. S.  
An improved solar panel and method for fabricating  
the same  
[NASA-CASE-NPO-14490-1]  
22 p0348 N79-18445
- CSIGI, K. I.  
Assessment of economic factors affecting the  
satellite power system. Volume 2: The systems  
implications of rectenna siting issues  
[NASA-CR-161186]  
22 p0368 N79-21552
- CUEVAS, A.  
Transcell, a novel approach for improving static  
photovoltaic concentration  
21 p0124 A79-17356
- CULLIS, C. F.  
The influence of lead compounds on automotive  
exhaust catalysts  
21 p0116 A79-17253
- CULVER, G. G.  
Thermosyphon models for downhole heat exchanger  
applications in shallow geothermal systems  
21 p0150 A79-18092

- CUNALI, Z. O.  
Analysis and design of solar buildings using the  
Cal-ERDA computer programs  
21 p0137 A79-17463
- CUNNINGHAM, J. E.  
Solar heating and cooling - An electric utility  
perspective  
21 p0093 A79-15890
- CUNNINGHAM, R. G.  
Mining earth's heat - Hot dry rock geothermal energy  
22 p0258 A79-23280
- CUNNINGHAM, H. E.  
Stored energy calculation: The state of the art  
[PNL-2581]  
21 p0210 N79-13541
- CURL, R. L.  
Direct thermomagnetic splitting of water  
22 p0312 A79-31154
- CURRAN, L. H.  
Preliminary environmental assessment of biomass  
conversion to synthetic fuels  
[PB-289775/9]  
22 p0365 N79-21224
- CURTIS, J. E.  
Effect of electrolyte impurity on the  
electrochemical performance of the  
lead/tetrafluoroboric acid/lead dioxide cell  
22 p0246 A79-21485
- CURTIS, S. A.  
Changes in the terrestrial  
atmosphere-ionosphere-magnetosphere system due  
to ion propulsion for solar power satellite  
placement  
[NASA-TN-79719]  
22 p0345 N79-17897
- CURTO, P.  
System for projecting the utilization of renewable  
resources. SPURR methodology  
[ERRQ/2322-77/4]  
21 p0174 N79-10538
- CUSUMANO, J. A.  
Catalysis in coal conversion  
21 p0051 A79-12873
- CWIERTNY, A. J., JR.  
On-orbit fabrication and assembly of large space  
structural subsystems  
[IAF PAPER 78-192]  
21 p0035 A79-11288

## D

- DA ROSA, A. V.  
Universal generator storer curves  
22 p0238 A79-20799
- DAFLER, J. R.  
A copper oxide-copper sulfate water-splitting cycle  
21 p0015 A79-10128
- A hybrid thermochemical hydrogen production cycle  
using solar energy process heat  
[AIAA PAPER 78-1779]  
21 p0062 A79-13874
- DAIELLO, R. V.  
Automated array assembly, phase 2  
[NASA-CR-158360]  
22 p0358 N79-20480
- DAILEY, N. S.  
An inventory of environmental impact models  
related to energy technologies  
[ORNL/EIS-147]  
22 p0372 N79-21640
- DAKSLA, C.  
Continuous extrusion of coal  
22 p0282 A79-26372
- DALLA BETTA, R. A.  
Catalysis in coal conversion  
21 p0051 A79-12873
- DALLEK, S.  
Differential scanning calorimetry studies of  
possible explosion-causing mixtures in Li/SO2  
cells  
22 p0246 A79-21487
- DARBY, B. W.  
Heat exchanger design for geothermal power plants  
21 p0015 A79-10123
- DANORE, F.  
Study of the applicability of the geochemistry of  
gases in geothermal prospecting  
21 p0075 A79-14736
- DANPIER, P. W.  
The secondary lithium electrode in non-aqueous  
electrolytes - Some problems, some solutions  
21 p0041 A79-11838
- DANSEHALA, P. R.  
Thermal analysis of receivers for solar  
concentrators and optimization procedure for  
power production  
21 p0182 N79-11465

- DANESHYAR, H.**  
A theoretical method for the prediction of monthly mean solar radiation parameters 21 p0022 A79-10183
- DANEY, D. E.**  
Some heat transfer and hydrodynamic problems associated with superconducting cables (SPTL) [NASA-TN-79023] 21 p0226 N79-15267
- DANG, V.-D.**  
Hydrogen production from high temperature electrolysis and fusion reactor 21 p0015 A79-10126
- DANIEL, J. L.**  
Development, characterization and evaluation of materials for open cycle MHD [PNL-2004-9] 22 p0361 N79-20504  
Development, characterization and evaluation of materials for open cycle MHD [PNL-2004-8] 22 p0369 N79-21557
- DANIELS, A.**  
The Stirling engine, an energy converter for cogeneration applications [ASME PAPER 78-WA/ENER-4] 21 p0159 A79-19777
- DANIELS, P. A.**  
Oahu wind power survey [PB-287361/0] 22 p0335 N79-16382
- DAPKURAS, S. J.**  
Materials and economics of energy systems 21 p0095 A79-15911
- DARNELL, J. E.**  
Geothermal power and water production studies at the University of California [ASME PAPER 78-WA/ENER-7] 21 p0159 A79-19778
- DAROOKA, D. K.**  
Melting multifoil insulation for KIPS emergency cooling 21 p0023 A79-10191
- DARSEY, D. H.**  
The USA 5MW solar thermal test facility 21 p0135 A79-17449  
Master control and data system for the 5MW Solar Thermal Test Facility 21 p0144 A79-17620  
Solar thermal test facility experiment manual [SAND-77-1173] 21 p0221 N79-14568
- DART, R. H.**  
Measurement and control techniques in geothermal power plants [TREE-1312] 22 p0362 N79-20508
- DARVAS, J.**  
Fuel technology and the environment 21 p0079 A79-14787  
The potential of fusion reactors as process heat source 22 p0284 A79-26624
- DAS, A. K.**  
A diagnostic study on the polycrystalline nature and its relationship with the yield of CdS solar cell 21 p0125 A79-17361
- DAS, S.**  
Investigation on junction formation and realisation of high open-circuit voltage in Cu<sub>x</sub>/S-CdS solar cells 21 p0123 A79-17344
- DAS, S. B.**  
Sprayed CdS thin films for CdS/Cu<sub>2</sub>S heterojunction solar cells 21 p0123 A79-17346  
Stoichiometric Cu<sub>2</sub>S thin films for solar cells 21 p0123 A79-17349
- DAUBNER, L.**  
Surtrace - An airborne geochemical system 22 p0255 A79-22557
- DAUD, T.**  
Effect of grain boundaries in silicon on minority-carrier diffusion length and solar-cell efficiency 22 p0252 A79-21807
- DAVE, J. V.**  
Performance of a tilted solar cell under various atmospheric conditions 21 p0066 A79-14261  
Isotropic distribution approximation in solar energy estimations 22 p0262 A79-23753
- DAVID, R. A.**  
Induction-generator/synchronous-condenser system for wind-turbine power 22 p0286 A79-27219
- DAVIDOV, D.**  
Hydrogen sorption properties in binary and pseudobinary intermetallic compounds 22 p0250 A79-21702
- DAVIDSON, K.**  
The National Program for Solar Energy 21 p0072 A79-14688
- DAVIES, J. H.**  
Surtrace - An airborne geochemical system 22 p0255 A79-22557
- DAVIS, D. B.**  
The USA 5MW solar thermal test facility 21 p0135 A79-17449  
Solar thermal test facility experiment manual [SAND-77-1173] 21 p0221 N79-14568
- DAVIS, E. E.**  
Construction of a 10GWe solar power satellite 21 p0003 A79-10029
- DAVIS, F.**  
Lead-acid battery: An evaluation of commercialization strategies [MTR-7593] 21 p0220 N79-14565
- DAVIS, G. D.**  
Study of flywheel energy storage Volume 1: Executive summary [PB-282652/7] 21 p0176 N79-10555  
Study of flywheel energy storage. Volume 2: Systems analysis [PB-282653/5] 21 p0176 N79-10556  
Study of flywheel energy storage. Volume 3: System mechanization [PB-282654/3] 21 p0177 N79-10557  
Study of flywheel energy storage. Volume 4: Life-cycle costs [PB-282655/0] 21 p0177 N79-10558  
Study of flywheel energy storage. Volume 5: Vehicle tests [PB-282656/8] 21 p0177 N79-10559
- DAVIS, H. P.**  
Solar power satellite 22 p0287 A79-27375
- DAVIS, H. S.**  
A technical analysis for cogeneration systems with potential applications in twelve California industrial plants 21 p0011 A79-10099
- DAVIS, J. J.**  
Wilson parameters for the system H<sub>2</sub>, N<sub>2</sub>, CO, CO<sub>2</sub>, CH<sub>4</sub>, H<sub>2</sub>S, CH<sub>3</sub>OH, and H<sub>2</sub>O 22 p0282 A79-26462
- DAVIS, J. R.**  
Phase two of the array automated assembly task for the low cost solar array project [NASA-CR-158359] 22 p0359 N79-20484
- DAVIS, K.**  
Preliminary assessment of the environmental impacts of the Satellite Power System /SPS/ 22 p0326 A79-31922
- DAVIS, S.**  
Recent results from the PLT tokamak 21 p0069 A79-14453
- DAVIS, S. H.**  
Coal and nuclear: A comparison of the cost of generating baseload electricity by region [PB-289585/2] 22 p0355 N79-19469
- DAVISON, J. E.**  
A feasibility study of inorganic oxide-fluoride compositions for thermal energy storage applications [AD-A059001] 21 p0196 N79-12559
- DAVITIAN, H.**  
A method for the comparative economic assessment of storage systems 21 p0013 A79-10111  
Wind power and electric utilities - A review of the problems and prospects 22 p0300 A79-29374
- DAVIDOVSKII, G. V.**  
Stability of combustion in the combustion chamber of an MHD generator 21 p0049 A79-12691
- DAWSON, A. G., III**  
Results and analysis of a round robin test program for liquid-heating flat-plate solar collectors 22 p0295 A79-28356

- DAWSON, B. E.  
Conceptual design of large heat exchangers for  
ocean thermal energy conversion  
[ASME PAPER 78-WA/HT-32] 21 p0161 A79-19813
- DAWSON, F. G.  
A summary of R&D programs 21 p0146 A79-17639
- DAY, W. H.  
Water-cooled gas turbine technology development -  
Fuels flexibility  
[ASME PAPER 79-GT-72] 22 p0307 A79-30536
- DAYAN, J.  
A new power cycle that combines power generation  
with energy storage 21 p0004 A79-10040
- DE BOER, A. A.  
Energy storage - Economics and fuel conservation 21 p0153 A79-18464
- DE GRAAF, J. D.  
Engineering and bench-scale studies of the  
sulfur-iodine cycle at General Atomic 21 p0015 A79-10127
- DE JONGE, A. K.  
A free-piston Stirling engine for small solar  
power plants 21 p0024 A79-10205
- DE SANTIAGO, E.  
Solar energy in Latin America - An overview 21 p0116 A79-17279
- DE WINTER, F.  
Solar energy and the flat plate collector - An  
annotated bibliography 21 p0090 A79-15858  
Sun: Mankind's future source of energy;  
Proceedings of the International Solar Energy  
Congress, New Delhi, India, January 16-21, 1978.  
Volumes 1, 2 & 3 21 p0116 A79-17276  
Optimum collection geometries for copper tube -  
copper sheet flat plate collectors 21 p0127 A79-17387
- DE WIT, H.  
Tilt, orientation and overshadowing of solar  
collectors in the Netherlands 21 p0131 A79-17414
- DEAN, S. O.  
Fusion power by magnetic confinement - Program plan 21 p0080 A79-14794
- DEB, S.  
Investigation on junction formation and  
realisation of high open-circuit voltage in  
Cu<sub>x</sub>/S-CdS solar cells 21 p0123 A79-17344
- DEBS, A. S.  
Solar energy research, development and  
demonstration program in Kuwait 21 p0117 A79-17282
- DECABLO, V. A.  
New processes for the recovery of resource  
materials from coal combustion wastes 21 p0007 A79-10065
- DECHER, R.  
MHD conversion of solar energy 21 p0109 A79-16614
- DECK, C.  
Conceptual design of a superconducting tokamak -  
'TORUS II SUPRA' 22 p0236 A79-20543
- DECKER, K.-D.  
The improved rigid airship 21 p0086 A79-15572
- DECKMAN, H. W.  
Fuel content characterization and pressure  
retention measurements of DT-filled laser fusion  
microballoon targets 22 p0258 A79-23034
- DENTER, C. R.  
Energy related mathematical models - Annotated  
bibliography 21 p0154 A79-18472
- DEGAN, A. E.  
A fundamental model for the evolution of a  
two-phase geothermal reservoir with application  
to environmental impact analysis 22 p0263 A79-23777
- DEGRAFF, J. V.  
A comparison of the silica and Na-K-Ca  
geothermometers for thermal springs in Utah 21 p0097 A79-16075

- DEGREY, S. P.  
Utilization of waste heat in trucks for increased  
fuel economy  
[NASA-TM-79966] 21 p0215 A79-13937
- DEIF, I. H.  
Stochastic predictions of solar cooling system  
performance  
[ASME PAPER 78-WA/SOL-16] 21 p0164 A79-19848  
System performance predictions for solar cooling  
using regional stochastic weather models 22 p0264 A79-23781
- DELAHOY, A. E.  
Heat exchanges and columnar growth in  
electron-beam evaporation of silicon films for  
solar cell applications 22 p0272 A79-25084
- DELANETER, W. B.  
Variable-displacement spark-ignition engine  
[SAND-77-8299] 21 p0172 A79-10435
- DELAWEY, C. L.  
Shale oil - The answer to the jet fuel  
availability question  
[SAE PAPER 781027] 22 p0274 A79-25900
- DELGADO, F. P.  
Recent operating experience of the Wellman-Lord  
FGD process on a coal-fired boiler 21 p0065 A79-14120
- DELL, R. H.  
Advanced batteries 21 p0067 A79-14270
- DELLIS, A. H.  
Heating and confinement in the CLEO stellarator 21 p0070 A79-14459
- DELYANNIS, A. A.  
Reflecting horizontal collector 21 p0128 A79-17395
- DELYANNIS, E. A.  
Reflecting horizontal collector 21 p0128 A79-17395
- DENRO, E. A.  
Perspectives on utility central station  
photovoltaic applications 21 p0041 A79-11873
- DENERLIAC, Y.  
The utilization of European space techniques for  
energy production  
[IAP PAPER 78-190] 21 p0035 A79-11287
- DEMICHELIS, F.  
Cavity-type surfaces for solar collectors 22 p0283 A79-26497
- DENNAN, O. S.  
A microwave power transmission system for space  
satellite power 21 p0002 A79-10025  
From sunlight in space to 60 Hz on earth - The  
losses along the way 21 p0003 A79-10027
- DENN, H. H.  
Feasible operating regions for moving bed coal  
gasification reactors 22 p0297 A79-28983
- DENNIS, B. E.  
Hot dry rock, an abundant clean energy resource 21 p0098 A79-16106
- DENNIS, R.  
A model for coal fly ash filtration 22 p0296 A79-28389
- DENNO, K.  
Compatibility of direct energy storage devices  
with ac. processing power system components 21 p0111 A79-16728  
Feasibility of MHD-ac induction electric power plant 22 p0303 A79-29794
- DERB, V. E.  
Effects of weather and pollution on incident solar  
energy - Basic measurements leading to computer  
models 21 p0065 A79-14117
- DERRINGTON, J.  
Principles of design and construction for marine  
structures for wave/tidal/ocean thermal energy 21 p0152 A79-18114
- DESAI, B. G.  
Solar electrification and rural electrification -  
A techno-economic review 21 p0118 A79-17289

- DESAL, T. B.  
Design and fabrication of silicon solar cells for concentrated light  
21 p0124 A79-17352
- DESARO, B.  
Controlled utilization of coal slag in the MHD topping cycle  
21 p0081 A79-14936
- DESAUTEL, J.  
Solar thermal conversion installations in the medium power range - The Thek project  
22 p0254 A79-22269
- DESMET, D.  
Development of surfaces optically suitable for flat solar panels  
[NASA-CR-150831]  
21 p0173 N79-10522
- DESTE, A.  
Electrolysis of zinc. Statistical model of the process parameters for an industrial cell  
[BLL-RTS-11317]  
22 p0345 N79-17984
- DEURERBUCK, A. W.  
EPA program conference report: Coal cleaning, an option for Increased Coal Utilization  
[PB-288223/1]  
22 p0344 N79-17378
- DEURERBUCK, A. W.  
An overview of coal preparation  
21 p0044 A79-12115
- DEUTSCHMANN, D.  
The Tritherm test house  
22 p0290 A79-27723
- DEVALETTE, R.  
A new thermochemical process for hydrogen production  
22 p0312 A79-31153
- DEVANEY, W. E.  
The design and fabrication of CdS/Cu<sub>2</sub>S cells of 8.5-percent conversion efficiency  
22 p0300 A79-29428
- DEVIN, B.  
Medium capacity heliothermal power stations  
21 p0142 A79-17507  
Current status and prospects for low-temperature solar energy  
22 p0269 A79-24623
- DEVIN, B. B.  
Report on the development of solar energy in France  
21 p0117 A79-17280
- DEVINE, W. D., JR.  
Net energy analysis of five energy systems  
[ORAU/IEA(R)-77-12]  
21 p0174 N79-10534
- DEVITT, T.  
Flue gas desulfurization system capabilities for coal-fired steam generators, volume 1. Executive summary  
[PB-284045/2]  
21 p0200 N79-12606
- DEVI, T. W.  
State-of-the-art assessment of air pollution control technologies for various waste-as-fuel processes  
21 p0064 A79-14111
- DEWAN, S. B.  
Thyristor controlled rectifier inverting at unity power factor  
21 p0033 A79-10898
- DEWINKEL, C. C.  
A low energy scenario for the United States - 1975-2050  
21 p0147 A79-17649
- DEY, S. K.  
Heat exchanges and columnar growth in electron-beam evaporation of silicon films for solar cell applications  
22 p0272 A79-25084
- DHARIAL, S. B.  
Response of p-n junction solar cells to concentrated sunlight and partial illumination  
21 p0124 A79-17353
- DI RAMIO, H.  
Structures for solar power satellites  
21 p0032 A79-10513
- DIAMOND, S. C.  
Verification methodology for the DOE-1 building energy analysis computer program  
[LA-UR-78-1493]  
21 p0208 N79-13520  
Component-based simulator for solar systems  
[LA-UR-78-1494]  
21 p0208 N79-13521
- DIBBLE, J. T.  
Stimulated biodegradation of waste petroleum  
22 p0336 N79-16388
- DIBLIN, J. A.  
Energy conservation in general aviation and operation and maintenance of Avco Lycoming piston engines  
21 p0048 A79-12381
- DICKET, J. W.  
Annual collection and storage of solar energy for the heating of buildings  
21 p0131 A79-17415
- DICKINSON, E. M.  
SPS microwave subsystem potential impacts and benefits  
21 p0107 A79-16603  
Satellite Power System (SPS) microwave subsystem impacts and benefits  
[NASA-CR-157951]  
21 p0196 N79-12558  
Microwave power transmitting phased array antenna research project  
[NASA-CR-157843]  
21 p0202 N79-13263
- DICKINSON, W. C.  
Annual available radiation for fixed and tracking collectors  
21 p0042 A79-11880
- DICKS, J. B.  
Economic optimization of the coal-fired MHD Steam Power Plant  
21 p0016 A79-10134  
Design studies and trade-off analyses for a superconducting magnet/MHD power generator system  
21 p0017 A79-10142  
Corrosion and deposits in MHD generator systems  
21 p0081 A79-14935
- DIEBTRICH, B.  
Solar water heating  
[BMFT-PB-T-77-42]  
22 p0349 N79-18457
- DIEBTRICH, G.  
Selective coatings for aluminum and steel solar absorbers  
21 p0058 A79-13647
- DIEZ PEREZ, J. A.  
Remote sensing use in hydraulic planification in Mexico  
22 p0255 A79-22522
- DIFIGLIO, C.  
Environmental conservation concerns in transportation: Energy, noise, and air quality  
[PB-286550/9]  
21 p0232 N79-15868
- DIGHE, S. V.  
Heat exchangers for Ocean Thermal Energy Conversion plants  
21 p0142 A79-17506
- DIJKHANS, A.  
Stratification effects in the short and long term storage of solar heat  
21 p0121 A79-17326
- DIKKERS, B. D.  
Plan for the development and implementation of standards for solar heating and cooling applications  
[PB-283237/6]  
21 p0190 N79-11543
- DILMORE, J. A.  
Development, testing and evaluation of MHD materials and component designs  
[PE-2248-19]  
22 p0369 N79-21558
- DINICK, D. L.  
Emissions and economy potential of prechamber stratified charge engines  
[SAE PAPER 790436]  
22 p0315 A79-31374
- DINOCK, D.  
Recent results from the PLT tokamak  
21 p0069 A79-14453
- DINELLI, G.  
Electrostatic precipitation tests with fuel oil ash  
22 p0296 A79-28390
- DINOVO, S. T.  
Preliminary environmental assessment of biomass conversion to synthetic fuels  
[PB-289775/9]  
22 p0365 N79-21224
- DIPIPPO, B.  
Geothermal preheating in fossil-fired steam power plants  
21 p0014 A79-10118  
Fossil superheating in geothermal steam power plants  
21 p0014 A79-10122  
Hybrid fossil-geothermal power plants  
21 p0096 A79-15920  
The geothermal power station at Ahuachapan, El Salvador  
22 p0266 A79-24239



- DIRHAN, L. A., JR.  
Annual collection and storage of solar energy for  
the heating of buildings 21 p0131 A79-17415
- DIVAKARAN, C. P.  
Power plant systems based on solar energy 21 p0142 A79-17508
- DIVAKARUNI, S. M.  
Simulation of solar powered Rankine cycle systems 21 p0022 A79-10179
- DIVITA, J.  
Clean Air Act amendments of 1977 and the impact on  
control efforts 21 p0097 A79-16091
- DIXIT, D. K.  
Some studies on an experimental solar pond 21 p0131 A79-17416
- DIXIT, P. N.  
Investigation on junction formation and  
realisation of high open-circuit voltage in  
Cu/x/S-CdS solar cells 21 p0123 A79-17344
- DNESTROVSKII, IU. N.  
Recombination-induced neutral-particle flux in  
tokamaks 22 p0291 A79-27877
- DOCKTER, L.  
Combustion rates for oil shale carbonaceous residue 21 p0032 A79-10522
- DODD, C. W.  
The brake system for the DOE/Sandia 17-meter  
vertical axis wind turbine 21 p0067 A79-14289  
Lightning protection for the vertical axis wind  
turbine [SAND-77-1241] 21 p0221 A79-14567
- DODGE, C. H.  
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[GPO-35-823] 21 p0232 A79-15815
- DODSON, J. G.  
Thermal conductivity of crystalline rocks  
associated with energy extraction for hot dry  
rock geothermal systems 22 p0304 A79-30123
- DOELLING, M.  
The economics and engineering of large-scale algae  
biomass energy systems [PB-287868/4] 21 p0226 A79-15207
- DOERNBERG, A.  
Energy use in Japan and the United States  
[BNL-23101] 21 p0221 A79-14578
- DOERNER, H.  
Expert opinion on wind energy conversion systems  
designed by Hermann Honnef [BMFT-PB-T-77-35] 22 p0349 A79-18456
- DOKBAS, V. N.  
Some studies on an experimental solar pond 21 p0131 A79-17416
- DOLAND, C.  
The dependence of optical properties on the  
structural composition of solar absorbers - Gold  
black 22 p0242 A79-21162  
Microstructure dependence of the optical  
properties of solar-absorbing black chrome 22 p0256 A79-22858
- DOLGIBEV, IU. B.  
Design of a heat pipe with separate channels for  
vapor and liquid 22 p0268 A79-24486
- DONALSKI, E. S.  
Test procedures for the determination of the gross  
caloric value of refuse and refuse-derived-fuels  
by oxygen bomb calorimetry: Summary of the 1977  
fiscal year results [PB-290160/1] 22 p0364 A79-21167
- DONINGUEZ, R. R.  
Local theory of finite-beta, collisional drift modes 22 p0253 A79-22244
- DONAHUE, P.  
Solar space heaters for low-income families  
[PB-289244/6] 22 p0363 A79-20526
- DONALDSON, A. B.  
Analysis and design of air heating unglazed flat  
plate solar collectors 22 p0280 A79-26202
- DONOVAN, R. L.  
Photovoltaic concentrating array 21 p0021 A79-10172
- DONOVAN, T. J.  
Late diagenetic indicators of buried oil and gas.  
2: Direct detection experiment at Cement and  
Garza fields, Oklahoma and Texas, using enhanced  
LANDSAT 1 and 2 images [E79-10099] 22 p0347 A79-18373
- DONOVON, R. H.  
Large wind turbine generators 21 p0092 A79-15881
- DOPERCHUK, I. I.  
Optimization of a diagonal MHD channel 22 p0247 A79-21628
- DORF, R. C.  
Energy, resources, and policy 22 p0304 A79-30175
- DORGAN, C. E.  
Residential energy design 21 p0073 A79-14694  
Building energy standards and codes 21 p0073 A79-14696
- DORF, D. W.  
Technology transfer at Department of Energy  
laboratories - Selected case studies from the  
Lawrence Livermore Laboratory 21 p0099 A79-16130
- DOROSHENKO, V. G.  
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photoconverters in the 100-400 K temperature range 21 p0167 A79-20361
- DOSS, E.  
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of MHD channels [AIAA PAPER 79-0189] 21 p0157 A79-19588  
Two-dimensional MHD channel design 22 p0279 A79-26183
- DOSS, E. D.  
Parametric study of the performance of a CDIF 1-B  
coal-fired MHD generator [ANL-MHD-79-3] 22 p0361 A79-20503
- DOUGHERTY, D. A.  
Effects of low solar input and amount of storage  
on thermosyphon hot water system performance 22 p0267 A79-24312
- DOUGLASS, D. L.  
The storage and release of hydrogen from magnesium  
alloy hydrides for vehicular applications 22 p0249 A79-21688
- DOWDY, H. W.  
The Otto-engine-equivalent vehicle concept  
[NASA-CR-157840] 21 p0203 A79-13370
- DOWELL, D.  
Urbanism and energy in developing regions  
[LBL-7808] 21 p0189 A79-11540
- DOWLER, W. L.  
Feasibility of rocket propellant production on Mars 21 p0047 A79-12324
- DOWNING, R. G.  
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applications. Volume 4: Electrical  
characteristics of Spectrolab BSF 200-micron  
Helios cells as a function of intensity and  
temperature [NASA-CR-157934] 21 p0195 A79-12543
- DOYLE, D. W.  
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- DOYLE, P. A.  
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evaporative cooling in a binary cycle geothermal  
power plant [ASME PAPER 78-WA/ENER-2] 21 p0159 A79-19775
- DRAKIN, L. H.  
Optimization and design of radiative  
heat-discharge system for energy unit with  
Stirling engine 21 p0166 A79-20348
- DRAGOO, A. L.  
Materials for fuel cells [PB-285360/4] 21 p0212 A79-13553
- DRAKE, R. L.  
Siting handbook for small wind energy conversion  
systems [PNL-2521] 21 p0209 A79-13527
- DRAKE, R. P.  
Evidence for neutral-beam-injected oxygen  
impurities in 2XIIIB 22 p0292 A79-27887

- DREWES, P. L.  
Allowable costs for alternative domestic heating systems using utility supplied electricity for backup or charging energy 22 p0319 A79-31428
- DREYLER, K. E.  
An aperture-augmented prototype power satellite 21 p0046 A79-12268
- DRIESEN, G. E.  
Development, testing and evaluation of MHD materials and component designs [FE-2248-19] 22 p0369 H79-21558
- DRIGGERS, J. E.  
Silicon web process development [NASA-CR-158376] 22 p0357 H79-20282
- DRIVER, P. E.  
The structure and properties of Cu based selective surfaces formed on an Al-Cu alloy by chemical brightening and etching treatments 21 p0127 A79-17384
- DRUI, O. S.  
Problems in the use of cryogenic pumps in thermonuclear synthesis 22 p0305 A79-30264
- DRUMMOND, J. E.  
Solar power satellites revisited 21 p0093 A79-15898
- DRYER, F. L.  
Combustion chemistry of chain hydrocarbons 21 p0052 A79-12986  
Fundamental combustion studies of emulsified fuels for diesel applications [PB-287386/7] 22 p0330 H79-16138
- DUA, C. R.  
Performance analysis of a flat-plate solar collector using 'forge-fin' tubes 22 p0316 A79-31404
- DUBE, G.  
A survey of laser glasses 21 p0083 A79-15140
- DUBBY, M.  
Technical and economic feasibility of making fertilizer from wind energy, water, and air 21 p0142 A79-17512
- DUBBY, R. C.  
A new fabrication process for single crystal silicon solar cells 21 p0122 A79-17335
- DUBOW, J. B.  
Potential for low cost, high efficiency solar cells using indium tin oxide on semiconductor /OSOS/ solar cells 21 p0122 A79-17338
- DUDKIN, L. D.  
Study of diffusion processes in low-temperature thermopiles 21 p0054 A79-13290
- DUDLEY, V. E.  
Concentrating solar collector test results, Collector Module Test Facility [SAND-78-0815] 21 p0208 H79-13522  
Performance testing of the Hexcel Parabolic Trough Solar Collector [SAND-76-0381] 21 p0221 H79-14569
- DUFF, G. P. D.  
Tidal power in the Bay of Fundy 22 p0237 A79-20729
- DUFF, W. S.  
Solar thermal electric power systems - Manufacturing cost estimation and systems optimization 21 p0046 A79-12273  
Potential for low cost, high efficiency solar cells using indium tin oxide on semiconductor /OSOS/ solar cells 21 p0122 A79-17338  
Simulation and design of evacuated tubular solar residential air conditioning systems and comparison with actual performance 21 p0138 A79-17475  
A Markov model of solar energy systems 21 p0138 A79-17476  
Integration of evacuated tubular solar collectors with lithium bromide absorption cooling systems 21 p0139 A79-17483  
Solar thermal electric power systems - Comparison of line-focus collectors 22 p0263 A79-23758
- Solar heating, cooling and hot water production - A critical look at CCMS installations 22 p0275 A79-25931
- Performance of residential solar heating and cooling system with flat-plate and evacuated tubular collectors - CSU Solar House I 22 p0276 A79-25939
- A Markov model of solar energy space and hot water heating systems 22 p0295 A79-28353
- Evaluation of high performance evacuated tubular collectors in a residential heating and cooling system: Colorado State University Solar House 1 [COO-2577-14] 21 p0206 H79-13507
- Solar evacuated tube collector: Absorption chiller systems simulation [COO-2577-13] 21 p0209 H79-13530
- DUFFIE, J. A.  
Design of active solar heating systems 21 p0090 A79-15860
- DUFFIELD, C.  
Solar energy, water, and industrial systems in arid lands: Technological overview and annotated bibliography [PB-285129/3] 21 p0211 H79-13549
- DUFFY, J. L.  
Preparation and ionic conductivity of H3O<sup>+</sup>/beta' alumina 21 p0040 A79-11821
- DUGAN, V. L.  
Dispersed power systems and total energy [AIAA PAPER 78-1770] 21 p0062 A79-13868
- DUKE, K. E.  
Preliminary environmental assessment of biomass conversion to synthetic fuels [PB-289775/9] 22 p0365 H79-21224
- DUMORT, R. S.  
The Saskatchewan Conservation House - Some preliminary performance results 22 p0318 A79-31417  
Energy management through energy conservation in buildings 22 p0320 A79-31431  
Passive solar heating - Results from two Saskatchewan residences 22 p0322 A79-31444
- DUNCAN, C. S.  
Silicon web process development [NASA-CR-158376] 22 p0357 H79-20282
- DUNN, J. R.  
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- DUNN, P. F.  
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- DUNNING, J. S.  
High performance lithium/iron disulfide cells 21 p0010 A79-10087
- DUSCHA, R. A.  
Thermal energy storage for industrial waste heat recovery 21 p0012 A79-10101  
Thermal storage for industrial process and reject heat 22 p0243 A79-21300  
Thermal storage for industrial process and reject heat [NASA-TN-78994] 21 p0183 H79-11481  
The role of thermal energy storage in industrial energy conservation [NASA-TN-79122] 22 p0368 H79-21550
- DUSKE, J.  
Magnetotelluric and geoelectric measurements for geothermal exploration in the Phlegraean Fields /preliminary results/ 21 p0075 A79-14732
- DUTHIL, R.  
Conceptual design of a superconducting tokamak - 'TORUS II SUPRA' 22 p0236 A79-20543
- DUTRUY, B.  
The French CHERS 1 MW solar power plant 21 p0141 A79-17498
- DUTTON, G.  
Time, technology and capital - Do we have enough to solve the energy crisis 21 p0097 A79-16100

- DUVALL, J. J.  
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produced by controlled-state retort  
21 p0005 A79-10047
- DUVALL, H. D.  
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- DIKSTRA, D. I.  
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H-coal, and Exxon donor solvent processes  
[PB-287800/7] 22 p0344 N79-17365
- DZIERLENGA, P. S.  
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22 p0284 A79-26538
- DZITOV, H. S.  
Using N2O4 in a solar gas-turbine plant  
21 p0167 A79-20357
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- EARNEST, E. R.  
Combined cycle gas turbine for an automobile  
application  
21 p0019 A79-10157
- EASTMAN, G. Y.  
Cost effective solar collectors using heat pipes  
21 p0014 A79-10115
- EATON, W. W.  
Solar energy  
21 p0147 A79-17648
- EBY, P. A.  
Atlas of western surface-mined lands: Coal,  
uranium, and phosphate  
[PB-287846/0] 22 p0340 N79-17311
- ECKELS, B. E.  
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[AD-A060156] 21 p0216 N79-14239
- ECKHART, H. H.  
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energy conservation programs  
21 p0072 A79-14684
- ECKERT, E. R. G.  
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21 p0155 A79-18973
- ECKHOFF, B. D.  
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[AIAA PAPER 78-1774] 21 p0062 A79-13871
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21 p0076 A79-14763
- ECKLUND, B. E.  
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for highway transportation  
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- Comparative automotive engine operation when  
fueled with ethanol and methanol  
[HCP/W1737-01] 21 p0201 N79-13189
- ECKSTEIN, L.  
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[PB-284480/1] 21 p0211 N79-13548
- EDEN, A.  
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solar energy collectors  
22 p0242 A79-21171
- EDENBURN, H. W.  
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technology development project  
[SAND-78-0948C] 21 p0176 N79-10550
- EDIE, D. D.  
Heat transfer and calorimetric studies of a direct  
contact-latent heat energy storage system  
22 p0281 A79-26210
- EDWARDS, S.  
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the regional level  
22 p0256 A79-22756
- Geothermal element, Imperial County, California  
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- EDSINGER, R. W.  
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storage systems  
21 p0029 A79-10241
- EDWALL, D. D.  
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22 p0261 A79-23710

- EDWARDS, B. P.  
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21 p0150 A79-18025
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concentration - Non-focusing lens with secondary  
concentrator  
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- EGGERS, A. G.  
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materials and component designs  
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- EGGERS, G. B.  
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Mirror Solar Concentrator field  
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- EGURUN, J.  
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photovoltaic concentration  
21 p0124 A79-17356
- EHRENSPECK, H.  
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- EHRLICH, K. A.  
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21 p0224 N79-15108
- EIBLING, J. A.  
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irrigation system  
21 p0144 A79-17525
- EINARSSON, S. S.  
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America and other tropical countries  
21 p0097 A79-16074
- EKOUHOHO, A.  
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collectors  
21 p0127 A79-17380
- EL DEHINI, M. M.  
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magnets  
22 p0236 A79-20536
- EL GABALAWI, M.  
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solar thermal electric power plants  
21 p0021 A79-10173
- EL-DEHINI, Z.  
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22 p0279 A79-26183
- EL-GABALI, M.  
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metal-insulator-semiconductor structure  
21 p0123 A79-17343
- EL-WAKIL, M. M.  
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honeycomb solar collector cells  
21 p0129 A79-17398
- Natural convection heat transfer in small and  
moderate aspect ratio enclosures - An  
application to flat plate collectors  
22 p0281 A79-26206
- ELCHAK, T. L.  
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Pennsylvania  
[PB-287577/1] 22 p0343 N79-17353
- ELDRIDGE, L. L.  
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- ELENELACH, M.  
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matrix metal-hydrides  
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- ELISEEV, V. B.  
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evacuated tubular elements with multilayer and  
selective coatings  
21 p0167 A79-20356

- ELKO, D. G.  
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vertical axis wind turbine rotor  
[TID-27754] 21 p0174 A79-10533
- ELLIOTT, D. C.  
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Its potential for energy conservation  
[BBWL-2137] 21 p0170 A79-10179
- ELLIOTT, G. R. B.  
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from dry, southwestern coals 21 p0005 A79-10050  
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load-leveling at sites for underground coal  
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- ELLIOTT, R. C.  
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- ELLIS, H. J.  
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[WP-23292] 21 p0211 A79-13543
- ELLISON, W.  
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removal by absorption-reduction scrubbing  
21 p0066 A79-14125
- ELSWER, H. B.  
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copper-silver-selenide thermoelectric materials  
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- EMETS, P. P.  
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22 p0299 A79-29298
- EMREN, A. T.  
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21 p0077 A79-14772
- ENDER, A. IA.  
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22 p0241 A79-20940
- ENGELMANN, P.  
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low-density regime of tokamaks 22 p0270 A79-24852
- ENGHOLM, G.  
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- ENGIBA, R. H.  
Design fabrication and testing of three meter  
diameter parabolic dish heliostat system  
21 p0135 A79-17447
- ENGLAND, C.  
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- ENGLAND, G. C.  
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parameters  
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- ENGLAND, P. C.  
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- ENGLISH, R. E.  
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- EPLER, J. L.  
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use of short-term for mutagenicity in the  
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- EPPELBY, W. E.  
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development 21 p0007 A79-10060  
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liquefaction process development 21 p0092 A79-15889
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emissions of flame-tube combustor using jet A fuel  
[NASA-TP-1393] 21 p0215 A79-14099
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- ERMAK, D. L.  
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21 p0116 A79-17262
- ERNEST, Y. P.  
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Antireflection-coated Metal-Oxide-Semiconductor  
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- ERNST, D. H.  
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- ERNST, E. H.  
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scale experiment at Shenandoah, Georgia  
[AIAA PAPER 78-1776] 21 p0062 A79-13873  
Background and system description of the Mod 1  
wind turbine generator 22 p0239 A79-20825
- ESBENSEN, T. V.  
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a combination of solar and wind energy 21 p0058 A79-13652  
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- ESCHER, W. J. D.  
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falling water 21 p0015 A79-10129
- ESKENSEN, J. H.  
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- ESSENWANGER, O. H.  
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surface 21 p0165 A79-20139
- EUSTIS, R. H.  
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- EVANS, A. K.  
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- EVANS, D. V.  
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independently oscillating bodies 21 p0151 A79-18103  
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[NASA-CASE-LEW-12819-1] 21 p0182 A79-11467  
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[NASA-CASE-LEW-12552-2] 21 p0182 A79-11472
- EVANS, R. A.  
Oil shale retorting - A correlation of selected  
infrared absorbance bands with process heating  
rates and oil yield 22 p0304 A79-29975
- EVANS, R. D.  
An inexpensive multiplexer temperature measuring  
system for monitoring and evaluation of solar  
collectors 21 p0089 A79-15847
- EVDOKIMOV, V. H.  
New models of solar cells and prospects for their  
optimization 21 p0166 A79-20346
- EWE, H.  
Hydrogen production by conventional and modified  
water electrolysis 21 p0059 A79-13659  
Generation of electrical energy from hydrogen and  
oxygen by means of fuel cells 21 p0059 A79-13662

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- FABRIS, G.  
The role of interfacial heat and mechanical energy transfers in a liquid-metal MHD generator.  
[ASME PAPER 78-WA/HT-33] 21 p0161 A79-19814  
Experimental two-phase liquid-metal magnetohydrodynamic generator program  
[AD-A059240] 21 p0197 N79-12564
- FAPARNAN, L. H.  
Earth-conducted heat losses from thermal storage systems 22 p0281 A79-26208
- FASY, L. J.  
Oil recovery from a Utah tar sand deposit by in situ combustion 21 p0004 A79-10043
- FAIRBANKS, J. W.  
Advanced industrial gas turbine cooling and high pressure compressor technology 21 p0004 A79-10041
- FAB, J. C. C.  
Selective-black absorbers using sputtered cermet films 22 p0327 A79-31969
- FANINGER, G.  
Solar energy activities in Austria 21 p0117 A79-17283
- PARAHAT, H. H.  
Thermal management of the lithium/metal sulfide electric vehicle  
[SAE PAPER 790161] 22 p0315 A79-31366
- FARBBER, E. A.  
The design and evaluation of a hydraulic-solar powered tracking device 21 p0136 A79-17458  
Theoretical basis and design for a residential size solar powered ammonia/water absorption air conditioning system 21 p0139 A79-17479  
An experimental evaluation of an intermittent cycle solar-powered ammonia/water absorption air conditioning system 21 p0139 A79-17481
- FARLEY, P. J. H.  
A wave power machine using free floating vertical plates 21 p0151 A79-18104
- FARMER, R. C.  
Combustion kinetics of selected aromatic hydrocarbons  
[AD-A059381] 21 p0215 N79-14184
- FARQUHAR, J.  
Non-electric applications of geothermal energy in six Alaskan towns  
[IDO-1622-4] 21 p0208 N79-13523
- FARRILL, K. W., JR.  
A synoptic description of coal basins via image processing  
[NASA-CR-157970] 21 p0204 N79-13474
- FARRINGTON, G. C.  
Preparation and ionic conductivity of H3C+/ beta alumina 21 p0040 A79-11821
- FARRIS, P.  
Venture analysis case study for on-site fuel cell energy systems  
[PCR-0783-VOL-1] 22 p0361 N79-20505
- FAY, R.  
Photoelectrolysis of water with semiconductors 22 p0259 A79-23343
- FEDIANIN, O. I.  
Properties of the plasma ions and the particle lifetime in ohmic heating in the I-2 stellarator 22 p0244 A79-21428
- FEDOROVA, H. P.  
Radiation regime of inclined surfaces 22 p0282 A79-26353
- FEINBERG, A.  
Thermal power systems small power systems applications project. Decision analysis for evaluating and ranking small solar thermal power system technologies. Volume 1: A brief introduction to multiattribute decision analysis  
[NASA-CR-158425] 22 p0368 N79-21548
- FEINGOLD, B.  
Is there repair after failure 21 p0086 A79-15378
- FEJER, A. A.  
Wind energy conversion 21 p0091 A79-15870
- PELLING, W. E.  
Coal research: Data systems and information transfer  
[ORAU-133] 21 p0232 N79-15830
- PELLS, I.  
Energy today and tomorrow 22 p0341 N79-17326
- PELS, H. F.  
Breakdown of rapid rail energy costs - A study of three systems 21 p0068 A79-14323
- FELTON, G. W.  
Catalyst development program for hydrosulfurization and liquefaction of coal to produce clean boiler fuels  
[FE-2321-12] 21 p0216 N79-14240
- FENDER, D. A.  
A theoretical analysis of solar collector/storage panels  
[ASME PAPER 78-WA/SOL-11] 21 p0163 A79-19843
- FENG, T.  
Merocyanine organic solar cells 21 p0165 A79-20216  
Angle-of-incidence effects in electron-beam-deposited SnO2/Si solar cells 22 p0272 A79-25069
- FERTON, J. B.  
An air/fuel control system for the Stirling engine  
[SAE PAPER 790328] 22 p0315 A79-31369
- FERTON, R.  
Solar space heaters for low-income families  
[PB-289244/6] 22 p0363 N79-20526
- FEOKTISTOV, L. P.  
Hybrid reactor based on laser-induced thermonuclear fusion 21 p0032 A79-10658
- FERRER, R. R.  
JPL - Small Power Systems Applications Project 21 p0019 A79-10161
- FERGUSON, B. K.  
Regional analysis of potential water power 21 p0148 A79-17825
- FERGUSON, P. A.  
Preliminary environmental assessment of energy conversion processes for agricultural and forest product residues, volume 1  
[PB-281189/1] 21 p0178 N79-10574
- FERNANDES, J. H.  
Solid waste and coal firing in industrial boilers 21 p0096 A79-15918
- FERNELIUS, W. A.  
East Mesa geothermal test site 22 p0259 A79-23458
- FERRARA, A. A.  
Thermal energy storage heat exchanger design  
[ASME PAPER 78-ENAS-30] 21 p0049 A79-12579
- FERRARO, B. J.  
EPRI/TVA pilot electric vehicle demonstration program  
[SAE PAPER 790110] 22 p0314 A79-31357
- FERTIS, D. G.  
Evaluation of urethane for feasibility of use in wind turbine blade design  
[NASA-CR-159530] 22 p0360 N79-20497
- FRUSTEL, J. E.  
Exploitation of solar energy via modular power plants and multiple utilization of waste heat 21 p0141 A79-17497
- FICKETT, A. P.  
Fuel cell electrocatalysis - Where have we failed 21 p0039 A79-11810  
Fuel-cell power plants 21 p0068 A79-14398
- FIDONE, I.  
Non-thermal emission at the plasma frequency 22 p0270 A79-24854
- FIEGL, G.  
LSI large area silicon sheet task continuous liquid feed Czochralski growth  
[NASA-CR-158366] 22 p0357 N79-20281
- FIELDING, S. J.  
Review of results from DITE tokamak 21 p0069 A79-14456
- FILE, J.  
SIPI - Superconducting Long-Pulse Tokamak Experiment 22 p0237 A79-20557

- FILIPPOV, N. V.  
Structure of the current shell in a Z pinch  
22 p0245 A79-21434
- FILLO, J.  
Hydrogen production from high temperature electrolysis and fusion reactor  
21 p0015 A79-10126  
The fast power cycle for fusion reactors  
21 p0018 A79-10152
- FILSON, F. E., JR.  
Controls for heat reclaim with thermal storage coupled with solar heating  
21 p0102 A79-16420
- FINDLEY, C. E.  
A methodology for evaluating the potential materials and energy recovery from municipal solid waste  
21 p0215 A79-13935
- FINEGOLD, J. G.  
Utilization of waste heat in trucks for increased fuel economy  
[NASA-TN-79966]  
21 p0215 A79-13937
- FINKE, R. C.  
Power management and control for space systems  
21 p0170 A79-10134
- FINKELSTEIN, T.  
Balanced compounding of Stirling machines  
21 p0024 A79-10200
- FIREBAUGH, M. W.  
Perspectives on energy: Issues, ideas, and environmental dilemmas /2nd edition/  
21 p0147 A79-17646
- FISCH, B.  
A parametric investigation on flat-plate solar collectors  
21 p0128 A79-17391
- FISCHBACH, P. E.  
25 kilowatt photovoltaic powered irrigation and grain drying experiment  
21 p0143 A79-17519
- FISCHER, A. K.  
Experimental two-phase liquid-metal magnetohydrodynamic generator program  
[AD-A059240]  
21 p0197 A79-12564
- FISCHER, J.  
Coal liquefaction support studies. Task 1: Heat of reaction of hydrogen with coal slurries.  
Task 2: Heat transfer coefficient  
[ABL/CEN/FE-77-5]  
21 p0216 A79-14242
- FISCHER, L. S.  
Stratification effects in the short and long term storage of solar heat  
21 p0121 A79-17326
- FISCHER, P.  
Localization and diffusion of hydrogen in lanthanum-nickel compounds  
22 p0248 A79-21682  
Hydrogen storage in  $\text{FeTi}$  - Surface segregation and its catalytic effect on hydrogenation and structural studies by means of neutron diffraction  
22 p0312 A79-31156
- FISCHER, R.  
Substitute natural gas from coal using high-temperature reactor heat - Project 'Prototype Plant Nuclear Process Heat'  
22 p0264 A79-23827
- FISCHER, R. D.  
The development of a 37 kW solar-powered irrigation system  
21 p0144 A79-17525
- FISCHER, S.  
Regulation and control concepts for the possibilities of a utilization of solar energy in the low-temperature range  
22 p0305 A79-30345
- FISCHER, W.  
The sodium/sulfur battery - A storage battery for peak load adjustment and electric traction  
21 p0165 A79-20244  
Recent advances in Na/S cell development - A review  
22 p0246 A79-21488  
Economic prospects for the application of new electric energy storage devices  
22 p0246 A79-21490
- FISCHL, R.  
Optimizing solar energy systems using continuous flow control  
21 p0138 A79-17477
- FISCUS, D. E.  
Evaluation of the Ames, Iowa refuse derived fuel recovery system  
21 p0064 A79-14115
- FISHER, E. R.  
Conceptual design of a solar powered closed-cycle gas turbine electric power generation system  
[ASME PAPER 79-GT-43]  
22 p0306 A79-30522
- FISHER, G. L.  
Chemical studies of stack fly ash from a coal-fired power plant  
22 p0309 A79-30595
- FISHER, S. T.  
Electrical induction heating of solid fossil fuels in situ - Some estimates  
22 p0304 A79-30215
- FISHMAN, C.  
Angle-of-incidence effects in electron-beam-deposited  $\text{SnO}_2/\text{Si}$  solar cells  
22 p0272 A79-25069
- FITZPATRICK, G. O.  
Thermionic power plant design point selection - The economic impact  
21 p0025 A79-10214  
Increasing the efficiency of coal-fired steam electric plants with thermionic topping  
21 p0096 A79-15921  
Thermionics and its application to the SPS  
21 p0109 A79-16616  
Power coupling alternatives for the NEP thermionic power system  
[NASA-CR-158372]  
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- FIVEL, B. J.  
Liquid metal heat pipe performance in the presence of a transverse magnetic field  
[ASME PAPER 78-ENAS-20]  
21 p0048 A79-12569
- FLANAGAN, C. A.  
Four ignition TNS Tokamak reactor systems: Design summary  
[ORNL/SUB-7117/25]  
21 p0193 A79-11889
- FLANAGAN, T. B.  
Hydrogen storage by  $\text{LaNi}_5$  - Fundamentals and applications  
21 p0038 A79-11803  
Thermodynamics of metal, alloy and intermetallic/hydrogen systems  
22 p0248 A79-21680  
Kinetics of hydrogen absorption and desorption  
22 p0248 A79-21687
- FLANIGAN, E. E.  
Field experience with the Detroit Diesel Allison 404/505 industrial gas turbine engines  
[SAE PAPER 790129]  
22 p0314 A79-31361
- FLEISCHMANN, C. W.  
Electric vehicle battery development  
[SAE PAPER 790158]  
22 p0314 A79-31363
- FLEHING, J. E.  
Slicing of silicon into sheet material: Silicon sheet growth development for the large area silicon sheet task of the Low Cost Silicon Solar Array project  
[NASA-CR-158082]  
22 p0333 A79-16365
- FLETCHER, E. A.  
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22 p0265 A79-24045
- FLOWER, J. O.  
Wave-tank experiments on an immersed parallel-plate duct  
22 p0258 A79-23306
- FLOWERS, A.  
Direction of gas supply research in the US  
22 p0340 A79-17320
- FOERSTER, S.  
The potential of fusion reactors as process heat source  
22 p0284 A79-26624
- FOGELSON, S.  
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[AD-A061071]  
22 p0342 A79-17341
- POB, S. E.  
A copper oxide-copper sulfate water-splitting cycle  
21 p0015 A79-10128  
A hybrid thermochemical hydrogen production cycle using solar energy process heat  
[AIAA PAPER 78-1779]  
21 p0062 A79-13874

- POKIN, V. G.  
Thermal deformations of solar-energy concentrators  
21 p0166 A79-20355
- POLEY, D.  
Conservation where it counts: Energy management systems  
[PB-289837/7] 22 p0372 N79-21628
- POLSON, B. A.  
Low NOx combustion concepts for advanced power generation systems firing low-Btu gas  
[PB-282983/6] 21 p0178 N79-10610
- POLSTAD, S.  
Venture analysis case study for on-site fuel cell energy systems  
[PCR-0783-VOL-1] 22 p0361 N79-20505
- FORD, F. E.  
Battery workshop  
Accelerated test program  
21 p0170 N79-10143  
22 p0370 N79-21577
- FORDYCE, J. S.  
Technology status: Batteries and fuel cells  
21 p0170 N79-10132
- FOREMAN, K. H.  
Experimental demonstration of the Diffuser Augmented Wind Turbine concept  
Fluid dynamics of diffuser-augmented wind turbines  
Diffuser designs for improved wind energy conversion  
21 p0029 A79-10238  
22 p0238 A79-20798  
22 p0279 A79-26182
- FOREMAN, W.  
The economics of electric power generation from wind energy  
22 p0310 A79-30998
- FORREST, H. J.  
Review of results from DITE tokamak  
21 p0069 A79-14456
- FORRESTER, R. C., III  
Alternatives for coal based power generation - An international overview  
21 p0008 A79-10074
- FORSTER, L. L.  
History and development of condensers at the Geysers geothermal power plant  
[ASME PAPER 78-JPGC-PWR-18] 21 p0150 A79-18099
- FORSYTH, J. B.  
Laser power conversion system analysis, volume 1  
[NASA-CR-159523-VOL-1] 22 p0366 N79-21334  
Laser power conversion system analysis, volume 2  
[NASA-CR-159523-VOL-2] 22 p0366 N79-21335
- FORTE, C.  
Silver selenate and silver tellurate as positive materials for lithium primary power sources  
22 p0245 A79-21484
- FORTUNATO, B.  
Simulation of solar powered Rankine cycle systems  
21 p0022 A79-10179
- FORTUNE, C. E.  
The measurement of the sulfuric acid and sulfate content of particulate matter resulting from the combustion of coal and oil  
21 p0156 A79-19219
- FOSS, A. S.  
A new power cycle that combines power generation with energy storage  
21 p0004 A79-10040
- FOSS, B. L.  
Fuel conservative subsonic transport  
22 p0337 N79-16874
- FOSSUM, J. G.  
Application of the superposition principle to solar-cell analysis  
22 p0300 A79-29426  
Development of high-efficiency P(+)-N-N(+) back-surface-field silicon solar cells  
[SAND-78-1156C] 21 p0188 N79-11529
- FOULETIER, H.  
A study of positive electrode materials for batteries operating in a halide-aluminate medium  
22 p0245 A79-21480
- FOWLER, C. F.  
Biological solar energy conversion approaches to overcome yield stability and product limitations  
[PB-284823/2] 21 p0199 N79-12577  
Biological solar energy conversion: Approaches to overcome yield, stability and product limitations  
[PB-286487/4] 21 p0230 N79-15422

- FRAAS, A. P.  
Fluidized bed gas turbine experimental unit for MIOUS applications  
[ORNL/HUD/MIOUS-32] 21 p0220 N79-14564  
Fluidized bed gas turbine experimental unit for MIOUS applications  
[ORNL/HUD/MIOUS-33] 21 p0221 N79-14575
- FRAIZE, W.  
Coal-fired gas turbine power cycles with steam injection  
21 p0004 A79-10042
- FRANK, E. A.  
US Army/Environmental Projection Agency re-refined engine oil program  
[AD-A056806] 21 p0171 N79-10216  
High sulfur fuel effects in a two-cycle high speed army diesel engine  
[AD-A059534] 21 p0216 N79-14232  
Direct utilization of crude oil as fuel in the US Army four-cycle diesel engine, model LDT-465-1C  
[AD-A062387] 22 p0357 N79-20279
- FRANCESCHI, J.  
Recent developments in pressurized fluidized bed coal combustion research  
[AIAA PAPER 79-0190] 21 p0157 A79-19589
- FRANCIS, M. S.  
The development of a laser Doppler velocimetry system for unsteady separated flow research: Preliminary results  
[AD-A061724] 22 p0352 N79-19305
- FRANCKEN, J. C.  
A heat pipe collector for low temperatures  
21 p0127 A79-17385
- FRANK, H. A.  
Primary lithium battery technology and its application to NASA missions  
[NASA-CR-158229] 22 p0354 N79-19449
- FRANK, H. J.  
Outlook for world oil into the 21st century with emphasis on the period to 1990  
[EPRI-BA-745] 21 p0181 N79-11454
- FRANK, R. I.  
Performance of a new high-intensity silicon solar cell  
22 p0257 A79-22862
- FRANK, T. G.  
Commercial applications of thermionic conversion using a fusion reactor energy source - A preliminary assessment  
21 p0026 A79-10219
- FRANKE, F. H.  
Gasification of raw lignite in the tube-furnace gasifier  
22 p0310 A79-30996
- FRANKEL, H. B.  
Materials and economics of energy systems  
21 p0095 A79-15911
- FRANKEL, I. F.  
Assessment of coal cleaning technology: An evaluation of chemical coal cleaning processes  
[PB-289493/9] 22 p0372 N79-21625
- FRANKLIN, A. D.  
Materials for fuel cells  
[PB-285360/4] 21 p0212 N79-13553
- FRANKLIN, C. J.  
Evaluation program for new industrial gas turbine materials  
[ASME PAPER 78-GT-145] 21 p0031 A79-10269
- FRANKLIN, I. V.  
A review of some critical aspects of satellite power systems  
22 p0326 A79-31921
- FRANTTI, E. W.  
Development, testing and evaluation of MRD materials and component designs  
[FE-2248-19] 22 p0369 N79-21558
- FRASER, M. D.  
Assessment of the potential of generating power from aqueous saline solutions by means of Osmo-Hydro Power systems  
21 p0016 A79-10133
- FREDERIKSE, H. P. R.  
Materials  
21 p0106 A79-16491
- FREDRICKSON, D.  
Coal liquefaction support studies. Task 1: Heat of reaction of hydrogen with coal slurries. Task 2: Heat transfer coefficient  
[ANL/CEN/FE-77-5] 21 p0216 N79-14242

- FREEDMAN, S. I.**  
Fluidized-bed combustion  
22 p0347 A79-18365
- FREEMAN, T. L.**  
Performance of combined solar-heat pump systems  
22 p0285 A79-26817
- FREITAG, R. P.**  
Evolution of space power systems  
[IAF PAPER 78-43]  
21 p0035 A79-11218  
Overview of future programs - USA  
21 p0116 A79-17275
- FREYNUTH, H.**  
The use of a sort of slide rule for the quick determination of solar irradiation of surfaces and through double glazing of arbitrary orientation and different inclination  
21 p0055 A79-13625
- FREYTAG, K.**  
Pulsed power supplied for large laser systems  
[UCRL-80113]  
21 p0217 A79-14377
- FRIEDMAN, R.**  
High-freezing-point fuels used for aviation turbine engines  
[ASME PAPER 79-GT-141]  
22 p0309 A79-30555
- FRIEDMAN, S.**  
Exploratory research in coal conversion  
21 p0007 A79-10061
- FRIEFLD, J. H.**  
External single pass to superheat receiver  
[AIAA PAPER 78-1751]  
21 p0089 A79-15849
- FRIELING, D. H.**  
The development of a 37 kW solar-powered irrigation system  
21 p0144 A79-17525
- FRIESEN, A. A.**  
Efficient Fresnel lens for solar concentration  
22 p0285 A79-26816
- FRIISCH, J. E.**  
The world balance for energy needs in view of year 2000: Development of the problem and areas involved, part 2  
[BLL-RISLEY-TR-3395-(9091.9P)]  
22 p0347 A79-18442
- FRIISWELL, R. J.**  
The influence of fuel composition on smoke emission from gas-turbine-type combustors - Effect of combustor design and operating conditions  
22 p0323 A79-31510
- FRIITS, D. H.**  
Some fatigue characteristics of nickel battery plaque  
[AD-A060370]  
21 p0230 A79-15415
- FROELING, W.**  
Substitute natural gas from coal using high-temperature reactor heat - Project 'Prototype Plant Nuclear Process Heat'  
22 p0264 A79-23827
- FROEHRING, J. E.**  
Performance testing of a three ton solar absorption chiller  
[AIAA PAPER 78-1757]  
21 p0060 A79-13858
- FROSCH, R. A.**  
Statement of Doctor Robert A. Frosch, Administrator, National Aeronautics and Space Administration  
21 p0224 A79-15111
- FROST, W.**  
Analysis of wind turbine generator rotor response to one-dimensional turbulence  
21 p0077 A79-14768  
Summary of atmospheric wind design criteria for wind energy conversion system development  
[NASA-TP-1389]  
21 p0223 A79-14678  
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[NASA-TP-1359]  
21 p0223 A79-14679
- FUEKI, K.**  
Progress in batteries and solar cells. Volume 1  
21 p0148 A79-17989
- FUEPFER, E.**  
New results in high-beta stellarator and belt-pinch research  
21 p0070 A79-14463
- FUJIE, K.**  
The use of heat exchangers with THERMOELECTRIC's tubing in ocean thermal energy power plants  
[ASME PAPER 78-WA/HT-65]  
21 p0162 A79-19825
- FUJII, A.**  
The testing procedures of thermal performance of solar collector at Solar Research Lab., G.I.R.I.  
21 p0130 A79-17409
- FUJII, I.**  
A new combustion system in the three-valve stratified charge engine  
[SAE PAPER 790439]  
22 p0316 A79-31376
- FUJII, K.**  
The thermochemical decomposition of water using bromine and iodine  
22 p0238 A79-20770
- FUJIMOTO, Y.**  
Analysis of a cylindrical imploding shock wave  
21 p0155 A79-18846
- FUJISHIMA, A.**  
Highly efficient quantum conversion at chlorophyll a-lectithin mixed monolayer coated electrodes  
22 p0273 A79-25548
- FUJITA, T.**  
Performance and economic risk evaluation of dispersed solar thermal power systems by Monte Carlo simulation  
21 p0020 A79-10163  
Comparative evaluation of distributed-collector solar thermal electric power plants  
21 p0021 A79-10173
- FULCHER, H. K.**  
East Mesa geothermal test site  
22 p0259 A79-23458
- FULLER, D.**  
USAF terrestrial energy study. Volume 3, part 1: Summary data display  
[AD-A061071]  
22 p0342 A79-17341
- FULLER, B. F.**  
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[PB-281815/1]  
21 p0189 A79-11542
- FUMBAUX, P.**  
Study of solid-gas-suspensions used for direct absorption of concentrated solar radiation  
22 p0262 A79-23757
- FURBER, J.**  
Concentrator photovoltaic systems for economical electricity and heat  
21 p0124 A79-17354
- FURINSKY, E.**  
Coke formation on hydrodesulphurization catalysts  
22 p0283 A79-26470
- FURRER, A.**  
Localization and diffusion of hydrogen in lanthanum-nickel compounds  
22 p0248 A79-21682
- FURST, G. B.**  
Review of optimization and economic evaluation of potential tidal power developments in the Bay of Fundy  
21 p0152 A79-18111
- FURTH, H. P.**  
Review of experimental results. I, II  
21 p0077 A79-14778
- FURUSAWA, T.**  
Flywheel energy storage system for JT-60 toroidal field coil  
21 p0112 A79-16729
- FUSSHANN, G.**  
On the motion of runaway electrons in momentum space  
22 p0291 A79-27880

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- GABANO, J. P.**  
Progress in batteries and solar cells. Volume 1  
21 p0148 A79-17989
- GABLE, R. D.**  
Brayton Isotope Power System - The versatile dynamic power converter  
21 p0023 A79-10190
- GADZHIEV, A. D.**  
Hybrid reactor based on laser-induced thermonuclear fusion  
21 p0032 A79-10658
- GAGE, S. J.**  
EPA program conference report: Coal cleaning, an option for Increased Coal Utilization  
[PB-288223/1]  
22 p0344 A79-17378
- GAGNON, W.**  
Pulsed power supplied for large laser systems  
[UCRL-80113]  
21 p0217 A79-14377



- GAHN, R. P.  
Factors affecting the open-circuit voltage and electrode kinetics of some iron/titanium/redox flow cells  
21 p0040 A79-11824  
Supply of reactants for Redox bulk energy storage systems  
[NASA-TM-78995] 21 p0183 N79-11479
- GAIA, H.  
A comparison between sun and wind as energy sources in irrigation plants  
21 p0118 A79-17295
- GALASCO, R. T.  
Discharge characteristics of a soluble iron-titanium battery system  
22 p0286 A79-26996
- GALKINA, N. S.  
Study of the spectral characteristics of metallized polymer films for production of solar concentrators  
22 p0297 A79-28672
- GALLAGHER, J. E., JR.  
Catalytic gasification predevelopment research  
21 p0029 A79-10246
- GALLET, P.  
Effect of physical properties of a flat plate solar collector cover on efficiency calculations - Simplifying hypotheses  
21 p0164 A79-19949
- GALLOPOULOS, N. E.  
Alternative fuels for reciprocating internal combustion engines  
21 p0051 A79-12980
- GALLOT, J.  
Latest developments in sponsored test programs for electric vehicles in France  
22 p0302 A79-29497
- GAMBUREZEV, S.  
Influence of the electrolyte content of oxygen carbon gas-diffusion electrodes on their electro-chemical performance in acid solutions  
22 p0245 A79-21483
- GANNON, R. B.  
The measurement of optical properties of selective surfaces using a solar calorimeter  
21 p0041 A79-11874
- GANDEL, M. G.  
Energy storage requirements for spacecraft  
22 p0246 A79-21486
- GANDHIDASAN, P.  
Rate of desorption in a solar regenerator  
21 p0055 A79-13611  
Buoyancy effects in a solar regenerator  
22 p0262 A79-23752
- GANEFELD, R. V.  
Stability of combustion in the combustion chamber of an MHD generator  
21 p0049 A79-12691  
Turbulence of a combustion product plasma in an MHD channel  
22 p0246 A79-21538
- GANGULI, P. S.  
Coal desulfurization by low-temperature chlorinolysis  
21 p0045 A79-12119
- GANNON, R. E.  
MHD power generation  
21 p0146 A79-17638
- GARBA, J. A.  
Parametric study of two planar high power flexible solar array concepts  
[NASA-CR-157841] 21 p0205 N79-13501
- GARBIN, H. D.  
Instrumentation for in situ coal gasification. IV - Seismic and acoustic techniques for remote monitoring  
22 p0304 A79-29974
- GARBUNY, H.  
Quasi-isentropic laser engines  
21 p0111 A79-16632
- GARD, H.  
Gas turbine with waste heat utilization - Low investment costs and high fuel use efficiency  
21 p0168 A79-20448
- GARG, H. P.  
Flat plate collector - Experimental studies and design data for India  
21 p0132 A79-17425
- Design, construction and performance of Fresnel lens for solar energy collection  
21 p0136 A79-17456
- GARIBOLDI, R. J.  
The National Program for Solar Energy  
21 p0072 A79-14688
- GARIBOTTI, J. P.  
On-orbit fabrication and assembly of large space structural subsystems  
[JAF PAPER 78-192] 21 p0035 A79-11288
- GARRETT, D. E.  
The Garrett Energy Research biomass gasification process  
21 p0004 A79-10037  
Conversion of biomass materials into gaseous products, phase 1  
[SAN/1241-77/1] 21 p0171 N79-10237
- GARRETT, L. B.  
Future large space systems opportunities: A case for space-to-space power?  
21 p0169 N79-10095
- GARRISON, J. D.  
A vacuum solar thermal collector with optimal concentration  
21 p0043 A79-11970  
A comparison of solar thermal energy collection using fixed and tracking collectors  
22 p0293 A79-28146
- GARVEY, L.  
Selenide technology evaluation program at JPL  
21 p0026 A79-10222
- GARVEY, L. P.  
Modified silicon-germanium alloys with improved performance  
21 p0027 A79-10225
- GASKINS, N. H.  
Compilation of level 1 environmental assessment data  
[PB-286924/6] 22 p0336 N79-16439
- GATES, R. W.  
A low energy scenario for the United States - 1975-2050  
21 p0147 A79-17649
- GATOS, H. C.  
Present status of GaAs  
[NASA-CR-3093] 21 p0215 N79-14192
- GAVALAS, G. R.  
Coal desulfurization by low-temperature chlorinolysis  
21 p0045 A79-12119
- GAVERILKO, S. A.  
Electromagnetic excitation of a moving conducting piston  
22 p0237 A79-20658
- GAVERILOVA, I. P.  
Optimization of electrical and optical characteristics of silicon photocells used for photothermal concentrated solar radiation converters  
21 p0053 A79-13288  
Solar-to-thermal energy converter based on coaxial evacuated tubular elements with multilayer and selective coatings  
21 p0167 A79-20356
- GAY, E. C.  
Advances in the development of lithium-aluminum/metal sulfide cells for electric-vehicle batteries  
21 p0010 A79-10089
- GAY, C. P.  
Ultra-thin silicon solar cells for high performance panel applications  
21 p0029 A79-10243
- GAY, E. C.  
Review of industrial participation in the ANL lithium/iron sulfide battery development program  
21 p0010 A79-10086
- GEHRER, B.  
Solar water heating  
[BMFT-PB-T-77-42] 22 p0349 N79-18457
- GEHRKE, H.  
Small solar power plant with a Freon turbine  
21 p0057 A79-13642  
A small solar power plant with a freon turbine  
21 p0141 A79-17501
- GELATT, C. D.  
Calculated heats of formation of metal and metal alloy hydrides  
22 p0249 A79-21690

- GELB, S. W.**  
Orbiting Solar Observatory /OSO-8/ solar panel design and in-orbit performance 21 p0001 A79-10017
- GELS, H. B.**  
Economic prospects for the application of new electric energy storage devices 22 p0246 A79-21490
- GENDLER, J.**  
Catalyst evaluation for denitrogenation of petroleum residua and coal liquids, phase 5 [PB-287180/4] 22 p0339 A79-17026
- GENENS, L.**  
A superconducting dipole magnet system for the MHD facility at Univ. of Tennessee Space Institute 21 p0017 A79-10140  
A superconducting dipole magnet for the UTSI MHD Facility 22 p0235 A79-20533
- GENEVY, P.**  
Conceptual design of a superconducting tokamak - 'TORUS II SUPRA' 22 p0236 A79-20543
- GENSLAK, S. L.**  
Emissions and economy potential of prechamber stratified charge engines [SAE PAPER 790436] 22 p0315 A79-31374
- GENUARIO, R. D.**  
Characterization of electron and ion current flow in very large aspect-ratio terawatt diodes employing heated and unheated anodes 21 p0154 A79-18480
- GEOLA, P.**  
Design and optimisation of an absorption refrigeration system operated by solar energy 22 p0285 A79-26819
- GERASIMOV, I. U. P.**  
Design of a heat pipe with separate channels for vapor and liquid 22 p0268 A79-24486
- GERASIMOV, S. W.**  
Effect of the magnetic configuration of the poloidal diverter on the plasma in the T-12 finger-ring tokamak 22 p0244 A79-21429
- GERISCHER, B.**  
Semiconductor electrodes for conversion and storage of solar energy 21 p0036 A79-11777
- GERSTLE, R.**  
Flue gas desulfurization system capabilities for coal-fired stream generators, volume 1. Executive summary [PB-284045/2] 21 p0200 A79-12606
- GERTH, H. L.**  
Mechanical deflection analysis of diamond turned reflective optics 21 p0083 A79-15143
- GERTSCH, W. D.**  
Soil cooling for geothermal electric power plants in the Western United States - The Raft River experiment 22 p0266 A79-24240
- GERVAIS, R. L.**  
A central receiver solar thermal power system 21 p0091 A79-15872
- GERSSIN, G.**  
Solar heating using a heat pump and cold collectors 22 p0254 A79-22268
- GEVANTHAN, L. B.**  
Evaluated physical properties data for materials used in energy storage systems [UCRL-81159] 21 p0189 A79-11536
- GEWEHR, H. W.**  
Wind-turbine-generator rotor-blade concepts with low-cost potential 22 p0240 A79-20828
- GEWIN, R. J.**  
A microwave power transmission system for space satellite power 21 p0002 A79-10025
- GEYER, B.**  
Two-dimensional MHD channel design 22 p0279 A79-26183
- GEYER, H. K.**  
Parametric study of the performance of a CDIF 1-B coal-fired MHD generator [ANL-MHD-79-3] 22 p0361 A79-20503
- GHANDHI, S. K.**  
Grain-boundary edge passivation of GaAs films by selective anodization 21 p0154 A79-18487  
Diffusion length measurements in Schottky barrier GaAs solar cells 22 p0281 A79-26243
- GHANINE, L.**  
New approaches for the appropriate use of solar energy in northern climates 22 p0319 A79-31424
- GHASSEMI, H.**  
Environmental assessment data base for high-Btu gasification technology. Volume 1: Technical discussion [PB-288602/6] 22 p0350 A79-18487  
Environmental assessment data base for high-Btu gasification technology. Volume 2: Appendices A, B, and C [PB-288603/4] 22 p0350 A79-18488  
Environmental assessment data base for high-Btu gasification technology. Volume 3: Appendices D, E, and F [PB-288604/2] 22 p0350 A79-18489  
Applicability of petroleum refinery control technologies to coal conversion [PB-288630/7] 22 p0352 A79-19173
- GHATAK, A. K.**  
Performance of solar concentrators - A theoretical study 21 p0135 A79-17453
- GHOSH, A. K.**  
Merocyanine organic solar cells 21 p0165 A79-20216  
Angle-of-incidence effects in electron-beam-deposited SnO<sub>2</sub>/Si solar cells 22 p0272 A79-25069
- GHOSH, S. B.**  
Design of a solar energy operated lithium-bromide water absorption refrigeration system for refrigeration storage 21 p0143 A79-17523
- GHOSH, S. P.**  
National Computer Conference, Anaheim, Calif., June 5-8, 1978, Proceedings 21 p0100 A79-16177
- GIANNAR, R. D.**  
Combustion of hydrothermally treated coals [PB-287521/9] 22 p0338 A79-17025
- GIANNOTTI, J. G.**  
Technology considerations in the design of a commercial offshore energy conversion /OTEC/ plant 22 p0288 A79-27378
- GIBBON, G. A.**  
Moessbauer spectroscopy of iron in coal and coal hydrogenation products 22 p0282 A79-26464
- GIBBS, L.**  
Flue gas desulfurization system capabilities for coal-fired stream generators, volume 1. Executive summary [PB-284045/2] 21 p0200 A79-12606
- GIBBS, L. L.**  
Particulate and sulfur dioxide emission control costs for large coal-fired boilers [PB-281271/7] 21 p0178 A79-10591
- GIBSON, A.**  
The JFT project - A step towards the production of power by nuclear fusion 22 p0326 A79-31918
- GIBSON, J.**  
Aviation fuels from coal 22 p0325 A79-31913
- GIBSON, B. A.**  
Studies in retiming tidal energy 21 p0152 A79-18115
- GIESE, R. F.**  
The interface with solar - Alternative auxiliary supply systems 21 p0137 A79-17468
- GIFT, B. H.**  
Proliferation-resistant nuclear fuel cycles [ORNL/TM-6392] 21 p0210 A79-13849
- GIKIS, B. J.**  
Preliminary environmental assessment of energy conversion processes for agricultural and forest product residues, volume 1 [PB-281189/1] 21 p0178 A79-10574

GILBERT, B. L.

PERSONAL AUTHOR INDEX

- GILBERT, B. L.  
Experimental demonstration of the Diffuser  
Augmented Wind Turbine concept  
21 p0029 A79-10238  
Fluid dynamics of diffuser-augmented wind turbines  
22 p0238 A79-20798  
Diffuser designs for improved wind energy conversion  
22 p0279 A79-26182
- GILBERT, J. A.  
Current state-of-the-art of electrochemical  
batteries from a users point of view  
21 p0071 A79-14681
- GILBERT, L. J.  
Control of wind turbine generators connected to  
power systems  
21 p0086 A79-15574  
Transient response to three-phase faults on a wind  
turbine generator  
21 p0180 A79-11312
- GILBERT, L. R.  
Black germanium solar selective absorber surfaces  
22 p0327 A79-31970
- GILBREATH, W. P.  
Enhanced solar energy options using earth-orbiting  
mirrors  
21 p0019 A79-10162  
Orbiting mirrors for terrestrial energy supply  
21 p0108 A79-16605  
A search for space energy alternatives  
21 p0108 A79-16608  
Space reflector technology and its system  
implications  
[AIAA PAPER 79-0545]  
22 p0273 A79-25852
- GILL, R. D.  
Review of results from DITE tokamak  
21 p0069 A79-14456
- GILLELAND, J. R.  
Doublet III design and construction  
21 p0018 A79-10145
- GILLET, I.  
Electrochemical use of biomass  
22 p0254 A79-22273
- GILLETT, D. A.  
Acceleration of solar heating application via  
improved data evaluation  
21 p0087 A79-15829
- GILLETT, P. R. C.  
Study on solar arrays for programmes leading from  
the extension of Spacelab towards space platforms  
[ESS/SS-878]  
22 p0335 A79-16379
- GILLIGAN, J. E.  
Suitable optical materials for solar collector  
applications  
22 p0239 A79-20823
- GILMAN, B. I.  
Characteristics of silicon photoconverters with  
inversion layer  
21 p0166 A79-20349
- GILMAN, S. P.  
Experience gained and lessons learned from  
monitoring the solar building, Albuquerque  
21 p0088 A79-15833
- GILMARTIN, T. J.  
The laser fusion scientific feasibility experiment  
21 p0030 A79-10250
- GINELL, W. S.  
Low-grade thermal energy-conversion Joule effect  
heat engines  
[ASME PAPER 78-ENAS-7]  
21 p0048 A79-12556  
Thermoclines: A solar thermal energy resource for  
enhanced hydroelectric power production  
22 p0237 A79-20730
- GINLEY, D. S.  
Role of semiconductor properties in  
photoelectrolysis  
21 p0037 A79-11780
- GIRAMONTI, A. J.  
Modeling the champagne effect in compressed air  
energy storage  
22 p0280 A79-26190
- GIRARD, J. P.  
On the ion energy balance in TFR with and without  
neutral injection heating  
21 p0069 A79-14452
- GIRI, N. K.  
Solar ammonia-water absorption system for cold  
storage application  
21 p0143 A79-17521

- GITLOW, B.  
Development of advanced fuel cell system  
[NASA-CR-159443]  
21 p0196 A79-12553
- GIUTRONICH, J. E.  
Manufacture of curved glass mirrors for linear  
concentrators  
21 p0136 A79-17459  
Ideal prism solar concentrators  
21 p0149 A79-18023  
Symmetrical and asymmetrical ideal cylindrical  
radiation transformers and concentrators  
22 p0303 A79-29647
- GLANTZ, M. H.  
Multidisciplinary research related to the  
atmospheric sciences  
[PB-283076/8]  
21 p0179 A79-10679
- GLASER, C. W.  
Heat pumps without supplemental heat  
21 p0073 A79-14695
- GLASER, P. E.  
Solar power satellite developments  
[AAS PAPER 78-022]  
21 p0035 A79-11558  
Health maintenance and health surveillance  
considerations for an SPS space construction  
base community  
[AAS PAPER 78-176]  
22 p0243 A79-21273  
The potential for solar energy development  
22 p0304 A79-30172  
Assessment of economic factors affecting the  
satellite power system. Volume 2: The systems  
implications of rectenna siting issues  
[NASA-CR-161186]  
22 p0368 A79-21552
- GLASGOW, J. C.  
Design and operating experience on the U.S.  
Department of Energy Experimental Mod-0 100 kW  
Wind Turbine  
21 p0028 A79-10234  
Utility operational experience on the NASA/DOE  
MOD-0A 200-kW wind turbine  
[NASA-TM-79084]  
22 p0360 A79-20494
- GLASOV, B. V.  
Problems in the use of cryogenic pumps in  
thermonuclear synthesis  
22 p0305 A79-30264
- GLASS, G. E.  
Ecological effects of coal-fired steam-electric  
generating stations  
22 p0346 A79-18358
- GLASS, M. C.  
Advancements in the design of solar array to  
battery charge current regulators  
21 p0033 A79-10902
- GLASS, N. R.  
Environmental effects of increased coal  
utilization ecological effects of gaseous  
emission from coal combustion  
[PB-285440/4]  
21 p0213 A79-13591
- GLASSMAN, I.  
Combustion chemistry of chain hydrocarbons  
21 p0052 A79-12986  
Fundamental combustion studies of emulsified fuels  
for diesel applications  
[PB-287386/7]  
22 p0330 A79-16138
- GLOVER, L., III  
Evaluation and targeting of geothermal energy  
resources in the southeastern United States  
[VPI-SU-5648-1]  
21 p0204 A79-13478
- GLUKHIKH, V. A.  
Calculation and design of liquid-metal MHD  
induction machines  
22 p0286 A79-27302
- GNECCO, A. J.  
Microprocessor control of a wind turbine generator  
22 p0244 A79-21302  
Microprocessor control of a wind turbine generator  
[NASA-TM-79021]  
21 p0195 A79-12548
- GOBIN, D.  
Theoretical and experimental analysis of a latent  
heat storage system  
21 p0121 A79-17323  
On the use of grating or mesh selective filters to  
increase the efficiency of flat plate solar  
collectors  
21 p0127 A79-17380  
Prediction of the behavior of a solar storage  
system by means of recurrent stochastic models  
22 p0258 A79-23295

- GODWIN, R. O.  
The laser fusion scientific feasibility experiment  
21 p0030 A79-10250
- GOEBEL, C. J.  
Selenide isotope generator for the Galileo mission  
21 p0022 A79-10185
- GOEBEL, F.  
Discharge reaction mechanisms in Li/SOC12 cells  
22 p0305 A79-30331
- GOEBEL, J.  
Solaronyx - Selective coating for solar energy absorbers  
21 p0058 A79-13648
- GOEBRICKE, P.  
Solar water heating  
[BMFT-PB-T-77-42]  
22 p0349 A79-18457
- GOETTL, E. J., IV  
Some measures of regional-industrial interfuel substitution potentials  
[BNL-24368]  
21 p0208 A79-13525
- GOENA, P. K.  
Selective coatings for solar energy conversion  
21 p0126 A79-17376
- GOH, T. E.  
Solar radiation studies for utilization of flat-plate collectors in an equatorial region  
21 p0119 A79-17311
- GOLAN, L. P.  
Solids mixing and fluidization characteristics in a tube filled bed  
21 p0008 A79-10070
- GOLANT, V. E.  
Experiments on adiabatic compression of a tokamak plasma in Tuman-2  
21 p0069 A79-14457
- GOLD, B.  
Power train analysis for the DOE/NASA 100-kW wind turbine generator  
[NASA-TN-78997]  
22 p0333 A79-16355  
Water-related environmental effects in fuel conversion, volume 1. Summary  
[PB-288313/0]  
22 p0351 A79-18834
- GOLDBERG, B.  
Flat plate collector dynamic evaluation  
21 p0128 A79-17390
- GOLDEN, J. A.  
Coal desulfurization using microwave energy  
[PB-285880/1]  
21 p0216 A79-14243
- GOLDEN, T. S.  
Baltimore applications project  
[NASA-TN-79667]  
22 p0351 A79-18815
- GOLDGRABER, G. E.  
An assessment of mercury emissions from fossil fueled power plants  
[PB-285227/5]  
21 p0213 A79-13592
- GOLDHAMMER, L. J.  
Orbiting Solar Observatory /OSO-8/ solar panel design and in-orbit performance  
21 p0001 A79-10017
- GOLDMAN, G. S.  
The Power Wheel - Elimination of energy-consuming drive components  
21 p0112 A79-16734
- GOLDMAN, B.  
Analysis and evaluation of process and equipment in tasks 2 and 4 of the Low Cost Solar Array project  
[NASA-CR-158089]  
22 p0335 A79-16378
- GOLDSMITH, E.  
Geothermal element, Imperial County, California  
[PB-287115/0]  
22 p0335 A79-16385
- GOLDSMITH, P.  
Solar array workshop  
21 p0170 A79-10142
- GOLDSTEIN, D. J.  
Water-related environmental effects in fuel conversion, volume 1. Summary  
[PB-288313/0]  
22 p0351 A79-18834  
Water-related environmental effects in fuel conversion. Volume 2: Appendices  
[PB-288874/1]  
22 p0356 A79-19496
- GOLDSTEIN, L., JR.  
Thermosyphon solar water heating system under Brasilian conditions  
21 p0021 A79-10177
- GOLDSTEIN, R. J.  
Heat transfer - A review of 1977 literature  
21 p0155 A79-18973
- GOLDSTEIN, R. H.  
A biologist's manual for the evaluation of impacts of coal-fired power plants on fish, wildlife and their habitats  
[PB-291330/9]  
22 p0373 A79-21679
- GOLDSTEIN, S. A.  
Microstability of a focused ion beam propagating through a z-pinch plasma  
22 p0270 A79-24817
- GOLDSTON, B. J.  
Radially resolved measurements of 'q' on the adiabatic toroidal compressor tokamak  
21 p0155 A79-18830  
Alpha transport and blistering in tokamaks  
22 p0253 A79-22243  
A simple neutral density profile calculation for tokamaks with lambda sub nfp much smaller than a  
22 p0255 A79-22379
- GOLDWATER, B.  
The Stirling engine for automotive application  
[SAE PAPER 790329]  
22 p0315 A79-31370
- GOLGER, A. L.  
Direct conversion of solar energy into laser radiation  
22 p0311 A79-31086
- GOLOVIN, A. H.  
Combustion of porous particles  
21 p0049 A79-12708
- GOLOVNER, T. H.  
Study of photoelectric characteristics of photocells made from high-resistivity silicon  
22 p0296 A79-28666
- GOMEZ, J. E.  
Transcell, a novel approach for improving static photovoltaic concentration  
21 p0124 A79-17356
- GONCZY, J.  
A superconducting dipole magnet for the UTSI MHD Facility  
22 p0235 A79-20533
- GONCZY, J. D.  
Cryogenic aspects of the U.S. SCMS superconducting dipole magnet for MHD research  
21 p0084 A79-15303  
Fabrication experiences and operating characteristics of the U.S. SCMS superconducting dipole magnet for MHD research  
21 p0084 A79-15304
- GOHEN, T.  
The impact of advanced technology on the future electric energy supply problem  
21 p0112 A79-16736
- GONZALEZ, C.  
Ball risk model for solar collectors  
21 p0098 A79-16103
- GOOD, B. E.  
Drop formation, evaporation modelling and environmental assessment of JP-4 fuel jettisoned from aircraft  
[AIAA PAPER 79-0186]  
21 p0157 A79-19585
- GOODELL, B. D.  
The impact of a coal fired power plant on ambient sulfur dioxide levels  
21 p0082 A79-15032
- GOODMAN, F. E., JR.  
Photovoltaic electric power generation from a utility perspective  
[ASME PAPER 79-SOL-18]  
22 p0309 A79-30552
- GOODMAN, E.  
A 5-GWe nuclear satellite power system conceptual design  
21 p0003 A79-10033
- GOODMAN, E. B.  
Compound parabolic concentrators with non-evacuated receivers - Prototype performance and a larger scale demonstration in a school heating system  
21 p0134 A79-17440
- GOODWIN, C. J.  
Space platforms for building large space structures  
21 p0032 A79-10511
- GOPALAKRISHNAN, K. V.  
Bio-mass energy for rural areas  
21 p0126 A79-17373
- GORADIA, C.  
A cost effective total energy system using a faceted mirror sunlight concentrator and high intensity solar cells  
21 p0135 A79-17446

- GORDON, L. H.  
Storage systems for solar thermal power  
21 p0013 A79-10108
- SINWEST - A simulation model for wind energy  
storage systems  
21 p0029 A79-10241
- Thermal storage technologies for solar industrial  
process heat applications  
[NASA-TM-79130]  
22 p0360 A79-20498
- GORMAN, R.  
Metal hydride solar heat pump and power system  
/HYCSOS/  
[AIAA PAPER 78-1762]  
21 p0061 A79-13863
- GORODETSKIY, S. M.  
Spectral characteristics of photoconverters with  
nonuniform defect distribution in the base  
21 p0053 A79-13289
- GORSKI, A. J.  
On the design of CPC photovoltaic solar collectors  
21 p0124 A79-17355
- GOSLICH, H.-D.  
Low-cost concept for energy supply from the wind  
21 p0058 A79-13651
- GOSS, J. R.  
Steam raising with low-Btu gas generators and  
potential for other applications  
21 p0072 A79-14690
- GOSSAID, D. M.  
Dynamics of stepping of the Hermes flexible solar  
array  
22 p0323 A79-31615
- GOTT, P.  
Recommended performance standards for electric and  
hybrid vehicles  
[SAS/1335-1]  
21 p0195 A79-12450
- GOULD, C. L.  
Large-scale human benefits from the  
industrialization of space  
21 p0099 A79-16136
- GOULD, R. K.  
Development of a model and computer code to  
describe solar grade silicon production processes  
[NASA-CR-158037]  
21 p0219 A79-14555
- GRAAB, J. A. E.  
Thermal management of the lithium/metal sulfide  
electric vehicle  
[SAE PAPER 790161]  
22 p0315 A79-31366
- GRAEBER, W.-D.  
Methane formation during the hydrogasification and  
the gas phase pyrolysis of defined aromatics  
22 p0265 A79-23829
- GRAHAM, L.  
Solar collector storage panel  
[ASME PAPER 78-WA/SOL-12]  
21 p0163 A79-19844
- GRALLERT, H. K. H.  
Experience with the MBE-solar testing house at  
Otterfing and relevant consequences on the  
commercial product  
22 p0276 A79-25934
- GRANQVIST, C. G.  
Selective absorption of solar energy by ultrafine  
metal particles  
21 p0127 A79-17382
- Selective absorption of solar energy in ultrafine  
metal particles - Model calculations  
22 p0273 A79-25746
- GRANRYD, E.  
Theory of solar assisted heat pumps  
21 p0090 A79-15864
- GRANT, A. J.  
Commercialization of fluidized-bed combustion  
systems by the State of Ohio  
21 p0096 A79-15923
- GRANVILLE, S.  
Alternative models of energy demand  
22 p0353 A79-19440
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Fluidized-bed combustion of low-quality fuels  
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- GUPTA, B. K.  
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- HANAKER, J.  
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- HANN, J. E.  
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- HANNEEL, T. E.  
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[PNL-2581] 21 p0210 N79-13541
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- HARDING, G. L.  
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- HARE, R. C.  
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[ORAU/IEA(M)-78-10] 21 p0209 N79-13531
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Factors affecting market initiation of solar total energy  
21 p0112 A79-16732
- HARRIS, A. W.  
The effects of internal latent energy storage on the operational dynamics of a solar-powered absorption cycle  
22 p0267 A79-24311
- HARRIS, B. F.  
Methods for the control of environmental damage caused by mining energy producing materials  
22 p0347 N79-18359
- HARRIS, G. S.  
Energy scenarios: Supplementary studies  
[NP-23292] 21 p0211 N79-13543
- HARRIS, I. R.  
The effect of induced disorder on the hydrogenation behaviour of the phase ZrCo  
22 p0251 A79-21707
- HARRIS, J. H.  
A ceramic heat exchanger for a Brayton cycle solar electric power plant  
22 p0239 A79-20822
- HARRIS, J. S., JR.  
/SH/x-GaAs polymer-semiconductor solar cells  
21 p0154 A79-18504  
High-efficiency AlGaAs/GaAs concentrator solar cells  
22 p0261 A79-23710
- HARRISON, S. J.  
Studies on solar collector performance at NRC  
22 p0322 A79-31451
- HARRISON, T. D.  
Solar Total Energy Test Facility project test results: High-temperature thermocline storage subsystem  
[SAND-77-1528] 21 p0197 N79-12565

- HARRISON, W. B.  
Coal-based electricity and air pollution control -  
A case for solvent refined coal 21 p0096 A79-15922
- HART, D.  
The honeycomb heat trap - Its application in flat  
plate solar collectors 22 p0322 A79-31447
- HARTE, J.  
Energy technologies and natural environments - The  
search for compatibility 21 p0074 A79-14721
- HARTLEY, R. P.  
Pollution perspective for geothermal energy  
development 21 p0064 A79-14114  
Pollution control guidance for geothermal energy  
development [PB-282546/1] 21 p0178 A79-10604
- HARTMAN, J. L.  
Electric vehicles challenge battery technology 21 p0093 A79-15892
- HARTMAN, J. S.  
Specularity measurements for solar materials 22 p0294 A79-28153
- HARTMAN, S.  
Flue gas desulfurization system capabilities for  
coal-fired stream generators, volume 1.  
Executive summary [PB-284045/2] 21 p0200 A79-12606
- HARTMAN, B.  
Casing materials for sodium/sulfur cells 22 p0245 A79-21481  
Recent advances in Na/S cell development - A review 22 p0246 A79-21488
- HARTSOCK, D. L.  
Test and development of ceramic combustors,  
stators, nose cones, and rotor tip shrouds 21 p0049 A79-12821
- HASAN, S.  
Recovery of oil from oil shale - An overall  
technological perspective 21 p0073 A79-14698
- HASELHAW, L. C.  
Computer modeling of automotive engine combustion  
[UCRL-80451] 21 p0181 A79-11412
- HASHEBY, H. H.  
Gasification Combined Cycle Test Facility at  
Pekin, Illinois 21 p0145 A79-17632
- HASLETT, J.  
The analysis by stochastic modelling of solar  
systems for space and water heating 21 p0137 A79-17466
- HASLETT, R. A.  
Thermal energy storage heat exchanger design  
[ASME PAPER 78-ENAS-30] 21 p0049 A79-12579
- HASSELBERG, G.  
Asymptotic theory of dissipative trapped electron  
mode overlapping many rational surfaces 22 p0270 A79-24855
- HASSENZAH, W. V.  
30-MJ superconducting magnetic energy storage  
/SMES/ unit for stabilizing an electric  
transmission system 22 p0237 A79-20555
- HASTINGS, L. J.  
Performance characteristics of a 1.8 by 3.7 meter  
Fresnel lens solar concentrator [NASA-TN-78222] 22 p0360 A79-20495
- HATCH, A. H.  
Design of superconducting magnets for full-scale  
MHD generators 21 p0084 A79-15306
- HATHI, V. V.  
Thermal and kinetic analysis of the pyrolysis of  
coals 22 p0336 A79-16704
- HATTORI, T.  
Rotating strength of glass-carbon fiber-reinforced  
hybrid composite discs 21 p0165 A79-20273
- HATTORI, Y.  
Effects of position of output electrodes in  
entrance region of open-cycle diagonal type MHD  
generator 21 p0153 A79-18468
- HATZIROCOPOIU, M.  
The advanced thermionic converter with microwave  
power as an auxiliary ionization source 21 p0153 A79-18470
- HAU, E.  
Flywheel energy accumulators for road vehicles 22 p0241 A79-20845
- HAUBENREICH, P. H.  
The role of the Large Coil Program in the  
development of superconducting magnets for  
fusion reactors 22 p0236 A79-20541
- HAUER, A.  
Measurements of compressed core density of  
laser-imploded targets by x-ray continuum-edge  
shift 21 p0154 A79-18479
- HAUPPE, W.  
The anodic oxidation of ethyleneglycol at  
platinum, gold and Pt/Au-alloys in alkaline  
solution 21 p0037 A79-11795
- HAUSER, J. B.  
A two-junction cascade solar-cell structure 22 p0256 A79-22856
- HAUSZ, W.  
Conceptual design of thermal energy storage  
systems for near term electric utility  
applications. Volume 1: Screening of concepts  
[NASA-CR-159411-VOL-1] 21 p0205 A79-13496
- HAVSTAD, P. H.  
Test and development of ceramic combustors,  
stators, nose cones, and rotor tip shrouds 21 p0049 A79-12821  
Evaluation of ceramics for stator application:  
Gas turbine engine report [NASA-CR-159533] 22 p0364 A79-21075
- HAWKINS, A. W.  
A standard procedure of economic evaluation for  
energy-producing and pollution-abatement  
operations 21 p0064 A79-14109
- HAWKINS, B. J.  
Cost analysis of new and retrofit hot-air type  
solar assisted heating systems [NASA-TN-78186] 21 p0173 A79-10519
- HAY, J. E.  
Measurement and modelling of shortwave radiation  
on inclined surfaces 22 p0242 A79-21062  
On the use of synoptic weather map typing to  
define solar radiation regimes 22 p0272 A79-25392
- HAY, R. D.  
Design of superconducting magnets for full-scale  
MHD generators 21 p0084 A79-15306
- HAYES, B. W.  
Antimony, arsenic, and mercury in the combustible  
fraction of municipal solid waste [PB-285196/2] 21 p0213 A79-13590
- HAYGOOD, K.  
Buildings energy use data book, edition 1  
[ORNL-5363] 22 p0348 A79-18447
- HAYNES, B. S.  
Kinetics of nitric oxide formation in combustion 21 p0053 A79-12989
- HAYNES, W. H.  
Liquid mixture excess volumes and total vapor  
pressures using a magnetic suspension densimeter  
with compositions determined by chromatographic  
analysis Methane plus ethane 21 p0085 A79-15324
- HAYS, R. A.  
Analysis of a Cassegrain solar furnace 22 p0293 A79-28147
- HAZELRIGG, G. A., JR.  
Costing the satellite power system [AAS PAPER 78-166] 22 p0243 A79-21270  
Economics of fusion research [COO-4181-] 21 p0193 A79-11890  
Assessment of economic factors affecting the  
satellite power system. Volume 1: System cost  
factors [NASA-CR-161185] 22 p0368 A79-21551

## HAZLETT, R. W.

- Further studies of fuels from alternate sources:  
 Fire extinguishment experiments with JP-5 jet  
 turbine fuel derived from shale  
 [AD-A058586] 21 p0201 N79-13182  
 Aging behavior of crude shale oil  
 [AD-A062420] 22 p0357 N79-20272

## HEALY, J. V.

- The influence of blade camber on the output of  
 vertical-axis wind turbines  
 21 p0045 A79-12242  
 An inverse problem of vertical-axis wind turbines  
 22 p0239 A79-20800

## HEAP, H. P.

- Use of alternative fuels in stationary combustors  
 21 p0052 A79-12981  
 The fate of fuel nitrogen - Implications for  
 combustor design and operation  
 21 p0080 A79-14927

- Combustion modification pollutant control  
 techniques for industrial boilers - The  
 influence of fuel oil properties and atomization  
 parameters  
 [ASME PAPER 78-WA/APC-13] 21 p0159 A79-19742  
 Low NOx combustion concepts for advanced power  
 generation systems firing low-Btu gas  
 [PB-282983/6] 21 p0178 N79-10610

## HEBENSTREIT, S.

- Resource analysis: Water and energy as linked  
 resources  
 [PB-288046/6] 22 p0349 N79-18463

## HECKEL, J.

- Designing and testing Si3N4 turbine components at  
 Mercedes-Benz  
 21 p0050 A79-12830

## HEDDEN, R. E.

- Application of solar cooling for a school building  
 in subtropics  
 21 p0103 A79-16461

## HEDGEPEATH, J. M.

- Ultralightweight structures for space power  
 21 p0108 A79-16609

## HEDRICK, C. L.

- Macroscopic stability and beta limit in the ELMO  
 Bumpy Torus  
 22 p0291 A79-27876

## HEDRICK, C. L., JR.

- Radial transport in the ELMO Bumpy Torus in  
 collisional regimes  
 22 p0312 A79-31184

## HEDSTROM, J. C.

- Passive solar heating of buildings  
 [LA-UR-77-1162] 21 p0090 A79-15859  
 Passive solar heating of buildings  
 22 p0275 A79-25928  
 Solar heating and cooling performance of the Los  
 Alamos National Security and Resources Study  
 Center  
 22 p0277 A79-25944

## HEGAXI, A. I.

- A channelled solar flat-plate booster  
 21 p0131 A79-17413

## HEIDTBAHN, U.

- Sea water desalination by means of solar energy  
 21 p0057 A79-13645  
 Solar water heating  
 [BMFT-PB-T-77-42] 22 p0349 N79-18457

## HEIMLICH, M. E.

- Silicon web process development  
 [NASA-CR-158376] 22 p0357 N79-20282

## HEIN, G. F.

- Photovoltaic power systems for rural areas of  
 developing countries  
 22 p0278 A79-26131  
 Photovoltaic power systems for rural areas of  
 developing countries  
 [NASA-TM-79097] 21 p0229 N79-15411

## HEINE, D.

- Investigation of physical and chemical properties  
 of phase change materials for space  
 heating/cooling applications  
 21 p0120 A79-17319

## HEINMILLER, W.

- Effects of low ambient temperature on the exhaust  
 emissions and fuel economy of 84 automobiles in  
 Chicago  
 [PB-288400/5] 22 p0355 N79-19488

## HEINZ, W.

- Superconducting magnets - Some fundamentals and  
 their state of the art  
 21 p0079 A79-14788

## HEISS, K.

- Statement of Doctor Klaus Heiss, President, ECON,  
 Incorporated, Princeton, New Jersey  
 21 p0224 N79-15110

## HEISS, K. P.

- Economic opportunities of space enterprise in the  
 next decades  
 21 p0100 A79-16137

## HEITBAUM, J.

- The anodic oxidation of ethyleneglycol at  
 platinum, gold and Pt/Au-alloys in alkaline  
 solution  
 21 p0037 A79-11795

## HELAVA, H.

- The effects of wall temperature on light  
 impurities in Alcatraz  
 22 p0313 A79-31188

## HELLER, A.

- Semiconductor liquid junction solar cells -  
 Efficiency, electrochemical stability, and  
 surface preparation  
 21 p0037 A79-11783

## HELLSTEN, T.

- MHD stability for a spherator with a purely  
 poloidal magnetic field  
 22 p0271 A79-24863

## HELNICK, H. H.

- Gaseous fuel reactors for power systems  
 [LA-UR-78-1437] 21 p0214 N79-13844

## HENSCH, M.

- Santa Clara Community Center Project, USA  
 22 p0277 A79-25945

## HENSORTH, M. C.

- Making turbofan engines more energy efficient  
 [ASME PAPER 78-GT-198] 21 p0033 A79-10818

## HENDERSON, J. B.

- Selected ordinates for total solar radiant  
 property evaluation from spectral data  
 22 p0271 A79-25060

## HENDERSON, T. M.

- Cryogenic pellets for laser-fusion research -  
 Theoretical and practical considerations  
 21 p0085 A79-15334  
 Point-contact conduction-cooling technique and  
 apparatus for cryogenic laser fusion pellets  
 21 p0085 A79-15335

## HENDRICKS, R. C.

- Some heat transfer and hydrodynamic problems  
 associated with superconducting cables (SPTL)  
 [NASA-TM-79023] 21 p0226 N79-15267

## HENDROM, B. H.

- Hot dry rock energy project  
 [LA-UR-77-2744] 21 p0175 N79-10540

## HENNESSEY, J. P., JR.

- A comparison of the Weibull and Rayleigh  
 distributions for estimating wind power potential  
 21 p0045 A79-12243

## HENNING, C. D.

- Superconductivity for mirror fusion  
 22 p0236 A79-20542

## HENRY, M. E.

- Late diagenetic indicators of buried oil and gas.  
 2: Direct detection experiment at Cement and  
 Garza fields, Oklahoma and Texas, using enhanced  
 LANDSAT 1 and 2 images  
 [E79-10099] 22 p0347 N79-18373

## HENSTOCK, M. E.

- The need for materials recycling  
 21 p0047 A79-12340

## HERCHAKOWSKI, A.

- Militarized thermoelectric power sources  
 21 p0027 A79-10227  
 Regenerative burner system for thermoelectric  
 power sources  
 22 p0261 A79-23621

## HERZFELD, P. R.

- Optimizing solar energy systems using continuous  
 flow control  
 21 p0138 A79-17477

## HEREDY, L. A.

- Lithium silicon - Iron sulfide load-leveling and  
 electric vehicle batteries  
 21 p0010 A79-10088

- HERNANCE, J. P.  
Toward assessing the geothermal potential of the Jemez Mountains volcanic complex: A telluric-magnetotelluric survey [LA-7656-MS] 22 p0358 N79-20458
- HERNANDEZ, W.  
The Philips experimental house - A system's performance study 22 p0277 A79-25941
- HERNANDEZ, H. L.  
A Stirling engine heat pump system 21 p0024 A79-10206
- HERN, J. L.  
Potential agricultural uses of fluidized bed combustion waste 21 p0064 A79-14108
- HERNANDEZ, E.  
Anticonvective antiradiative systems 21 p0132 A79-17420
- HERONIMUS, W. E.  
Development of compact heat exchangers for Ocean Thermal Energy Conversion (OTEC) systems [ASME PAPER 78-WA/HT-34] 21 p0161 A79-19815
- HERN, K. C.  
Augmented solar energy collection using different types of planar reflective surfaces - Theoretical calculations and experimental results 22 p0242 A79-21166  
Augmented solar energy collection using various planar reflective surfaces: Theoretical calculations and experimental results [LA-7041] 21 p0185 N79-11494
- HERRERA, G. G.  
Comparative evaluation of distributed-collector solar thermal electric power plants 21 p0021 A79-10173
- HERRERA, R.  
Anticonvective antiradiative systems 21 p0132 A79-17420
- HERRMANN, G.  
On the dynamics of electrostatically precipitated fly ash [ASME PAPER 78-WA/PU-3] 21 p0160 A79-19787
- HERTZBERG, A.  
A high temperature Rankine binary cycle for ground and space solar engine applications 21 p0108 A79-16613  
Laser aircraft propulsion 21 p0109 A79-16618  
Energy exchanger technology applied to laser heated engines 21 p0110 A79-16631  
Laser aircraft 22 p0284 A79-26597
- HERWIG, L. O.  
The accomplishments of the United States Federal Solar Energy Program 21 p0117 A79-17281
- HERZ, J.  
Performance of vacuum tube solar collector systems 21 p0102 A79-16424
- HESKEY, G. T.  
Magnetohydrodynamic lightweight channel development [AD-A060429] 21 p0230 N79-15414
- HESTER, O. V.  
A probabilistic model of insolation for the Mojave desert-area 21 p0076 A79-14766
- HEUER, J.  
Designing and testing Si3N4 turbine components at Mercedes-Benz 21 p0050 A79-12830
- HEWIG, G. E.  
Cu2S-CdS thin-film solar cells 21 p0057 A79-13637  
A pilot line for the production of large area Cu<sub>x</sub>/S-CdS solar cells 21 p0124 A79-17351
- HEWITT, E.  
A solar energy system with a dual-source heat pump and long-term storage 21 p0119 A79-17312
- HEWSON, E. W.  
Wind power potential in the Pacific Northwest 22 p0244 A79-21334
- HICKY, J. S.  
Laboratory evaluation of a composite flywheel energy storage system 21 p0013 A79-10110
- HICKOX, C. E.  
Solar Total Energy Test Facility project test results: High-temperature thermocline storage subsystem [SAND-77-1528] 21 p0197 N79-12565
- HIETBRINK, E. H.  
Electric vehicles challenge battery technology 21 p0093 A79-15892
- HIGGINS, E. H. R.  
Component cost of solar energy systems 22 p0319 A79-31429
- HIGGINS, J. H.  
Design of the data acquisition system at Solar One 21 p0088 A79-15841
- HIGGINS, S.  
The updated algorithm of the Energy Consumption Program (ECP): A computer model simulating heating and cooling energy loads in buildings 22 p0351 N79-19059
- HIGHTOWER, S. J.  
A proposed conceptual plan for integration of wind turbine generators with a hydroelectric system 21 p0098 A79-16107
- HILAL, H. A.  
Design criteria for multilayer superconductive magnets 22 p0236 A79-20536  
Refrigeration requirements for future superconductive energy related applications 22 p0311 A79-31019
- HILDEBRAND, R.  
Jet fuels from shale oil - A near term technology 21 p0005 A79-10045
- HILDEBRANDT, A. F.  
Net energy analysis and environmental aspects for solar tower central receiver systems. I - Methodology 21 p0097 A79-16101
- HILL, P. E.  
Silicon web process development [NASA-CR-158376] 22 p0357 N79-20282
- HILL, J. E.  
Testing of solar collectors according to ASHRAE Standard 93-77 21 p0101 A79-16417  
Testing of water-heating collectors according to ASHRAE Standard 93-77 21 p0130 A79-17410  
Results and analysis of a round robin test program for liquid-heating flat-plate solar collectors 22 p0295 A79-28356  
Experimental verification of a standard test procedure for solar collectors [PB-289912/8] 22 p0372 N79-21632
- HILL, R. D.  
Methods for the control of environmental damage caused by mining energy producing materials 22 p0347 N79-18359
- HILL, R. P.  
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- HILLENBRAND, L. J.  
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- HILLER, C. C.  
Sulfuric acid-water - Chemical heat pump/energy storage system demonstration 22 p0281 A79-26209
- HINY, A.  
Nickel-zinc vs. silver-zinc battery - A comparative study of baseline characteristics 21 p0009 A79-10083
- HINDERMAN, J. D.  
Selenide thermoelectric converter technology 21 p0026 A79-10221
- HINKLEY, L. G.  
Alternative energy sources for Federal Aviation Administration facilities [AD-A058681] 21 p0196 N79-12555
- HIRAHOTO, A.  
The theoretical analysis of an air turbine generation system 21 p0151 A79-18106

- HIRANO, H.  
A digital control system for superconducting magnet  
22 p0268 A79-24508
- HIRASAWA, S.  
The use of heat exchangers with THERMOEXCEL's  
tubing in ocean thermal energy power plants  
[ASME PAPER 78-WA/HT-65] 21 p0162 A79-19825
- HIRSHBERG, A. S.  
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heating  
22 p0292 A79-27899
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21 p0102 A79-16451  
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21 p0104 A79-16468
- HITTLE, D. C.  
Design of solar heating and cooling systems  
[AD-A062719] 22 p0363 N79-20522
- HIZA, H. J.  
Liquid mixture excess volumes and total vapor  
pressures using a magnetic suspension densimeter  
with compositions determined by chromatographic  
analysis Methane plus ethane  
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- HO, T.  
Energy-related pollutants in the environment: The  
use of short-term for mutagenicity in the  
isolation and identification of biohazards  
[CONF-780121-2] 21 p0192 N79-11568
- HOAGLAND, L. C.  
Potential of the Stirling engine for stationary  
power applications in the 500-2000 HP range  
21 p0025 A79-10211
- HOANG, D. C.  
The Garrett Energy Research biomass gasification  
process  
21 p0004 A79-10037
- ROCKENBERRY, K. A.  
Life-cycle costing. A guide for selecting energy  
conservation projects for public buildings  
[PB-287804/9] 22 p0345 N79-17744
- HODAM, R.  
Steam raising with low-Btu gas generators and  
potential for other applications  
21 p0072 A79-14690
- MODES, G.  
Polycrystalline CdSe-based photo-electrochemical  
cells  
21 p0037 A79-11785
- HODGES, C. W.  
The ClearView Solar Collector system and  
associated one and two stage evaporative cooling  
- Interim results  
[AIAA PAPER 78-1759] 21 p0061 A79-13860
- HODSON, D. R.  
Development of a high energy storage flywheel module  
[AD-A060351] 21 p0230 N79-15413
- HOEHN, P. W.  
Design of a preprototype Stirling Laboratory  
Research Engine  
21 p0024 A79-10203
- HOENIG, H. O.  
Design and development of the US-TESPE toroidal coil  
22 p0311 A79-31014
- HOERSTER, H.  
What and where - Solar active systems or energy  
conservation in buildings  
22 p0275 A79-25927  
The Philips experimental house - A system's  
performance study  
22 p0277 A79-25941
- HOERTZ, C.  
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commercial development at Ashland  
21 p0092 A79-15888
- HOERTZ, C. D.  
The H-Coal project  
21 p0145 A79-17635
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recovery  
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- HOFFMAN, J.  
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- HOFFMAN, L.  
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option for Increased Coal Utilization  
[PB-288223/1] 22 p0344 N79-17378
- HOFFMAN, H. A.  
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estimates for two electrostatic concepts  
21 p0046 A79-12266
- HOFFNAGLE, G. F.  
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Fossil fuel, steam electric generating industry  
21 p0064 A79-14112
- HOGAN, W. W.  
Energy and the economy  
[EPRI-EA-620-VOL-1] 21 p0189 N79-11539
- HOGG, G. H.  
Environmental factors affecting the installation  
and operation of gas turbine engines in  
agricultural aircraft  
[SAE PAPER 781010] 22 p0274 A79-25892
- HOKANSON, A. E.  
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economic study  
[FPL-12] 21 p0194 N79-12239
- HOKK, R. C.  
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combustion processes  
22 p0261 A79-23640
- HOLCOMB, L.  
NASA's OAST program: An overview  
22 p0370 N79-21574
- HOLCOMB, L. B.  
NASA's thermionic technology program  
21 p0026 A79-10217
- HOLDER, J. C.  
Investigation of the corrosion performance of  
boiler, air heater, and gas turbine alloys in  
fluidized combustion systems  
21 p0080 A79-14931
- HOLDREN, J.  
Energy for the long run - Fission or fusion  
22 p0256 A79-22760
- HOLICK, H.  
Development of high temperature fuel cell battery  
[BMFT-PB-T-77-17] 22 p0342 N79-17344
- HOLLA, V.  
Design and fabrication of silicon solar cells for  
concentrated light  
21 p0124 A79-17352
- HOLLANDER, J. H.  
Annual review of energy. Volume 3  
21 p0074 A79-14718
- HOLLANDS, K. G. T.  
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transmittance of transparent honeycombs  
21 p0042 A79-11877  
Optimization of the flow passage geometry for air  
heating solar collectors  
22 p0316 A79-31403  
Dimensional relations for free convective heat  
transfer in flat-plate collectors  
22 p0316 A79-31406  
Optimization studies on black chrome  
electroplating variables for solar selective  
surfaces  
22 p0317 A79-31407  
Studies on the effect of bed aspect ratios and  
pressure drop on flow distribution in rock bed  
storage systems for solar energy applications  
22 p0317 A79-31409  
A solar collector thermal performance test for  
developmental programs  
22 p0317 A79-31413  
Collector and storage efficiencies in solar  
heating systems  
22 p0320 A79-31432

- WATSON - A simulation program for solar-assisted heating systems 22 p0321 A79-31439
- Methods for reducing heat losses from flat plate solar collectors, phase 2 [COO-2597-4] 21 p0188 N79-11533
- HOLLIS, H. D. Energy utilization survey pamphlet for buildings [AD-A062930] 22 p0371 N79-21624
- HOLMES, J. D. Pressure measurements on wind tunnel models of the Aylesbury experimental house 22 p0300 A79-29372
- HOLMES, J. T. The USA 5kW solar thermal test facility 21 p0135 A79-17449
- Solar thermal test facility experiment manual [SAND-77-1173] 21 p0221 N79-14568
- HOLMES, R. E. Design of a freon jet pump for use in a solar cooling system [ASHE PAPER 78-WA/SOL-15] 21 p0164 A79-19847
- HOLMGREN, J. D. Westinghouse fluidized bed coal gasification system - Experience and plans 21 p0096 A79-15924
- HOLT, L. Distributed energy storage for solar applications 22 p0317 A79-31410
- HOLT, H. A. Incentives and requirements for gasification based power systems 21 p0094 A79-15904
- HOLTON, J. K. Interim performance criteria for solar heating and cooling systems in residential buildings, second edition [PB-289967/2] 22 p0372 N79-21630
- HOLTZ, R. E. Integrating technologies to produce energy conservation [CONF-780109-6] 21 p0189 N79-11541
- HOLTZ, R. P. Integral assembly of photovoltaic arrays using glass 22 p0241 A79-20883
- HOLZ, D. Results of measurements of solar radiation on surfaces of different orientations 21 p0055 A79-13622
- HOLZRICHTER, J. F. The laser fusion scientific feasibility experiment 21 p0030 A79-10250
- HONNA, T. Optimum power plant capacity of ocean-based ocean thermal energy conversion systems 22 p0297 A79-28922
- HONNEBT, P. J. Instrumentation for in situ coal gasification. II - Thermal and gas sampling diagnostic techniques 21 p0032 A79-10520
- HOMOLYA, J. B. The measurement of the sulfuric acid and sulfate content of particulate matter resulting from the combustion of coal and oil 21 p0156 A79-19219
- HONDA, K. Highly efficient quantum conversion at chlorophyll a-lectithin mixed monolayer coated electrodes 22 p0273 A79-25548
- HONDA, S. Efficiency studies about Daihatsu engine/electric hybrid system [SAE PAPER 790013] 22 p0314 A79-31352
- HONNA, T. The formulation of the wall stabilization problem of an axisymmetrical toroidal sharp-boundary plasma with a horizontally elongated noncircular cross section 22 p0327 A79-32103
- HOOK, W. R. Future large space systems opportunities: A case for space-to-space power? 21 p0169 N79-10095
- HOORN-FREER, D. Heattube, a universal electrical solar heat equipment for building, community and agricultural purposes 21 p0138 A79-17473
- HOOVER, L. J. Long-term availability of water resources for energy development in the Central United States 21 p0065 A79-14118
- HOPKINS, D. C. Limitations of solar assisted heat pump systems [ASHE PAPER 78-WA/SOL-1] 21 p0162 A79-19834
- HOPKINS, G. W. Optical design of a solar collector for the advanced solar thermal electric conversion/process heat program [Y/SUB-77/14261] 21 p0209 N79-13528
- HOPKINS, R. H. Silicon web process development [NASA-CR-158376] 22 p0357 N79-20282
- HOPMANN, R. Development of solar thermal power plants 21 p0057 A79-13641
- Development of small solar power plants for rural areas in India 21 p0141 A79-17502
- HOPPE, R. Brookhaven National Laboratory burner-boiler/furnace efficiency test project. Annual fuel use and efficiency reference manual: hydronic equipment [BNL-50816] 21 p0210 N79-13538
- HORAZAK, D. A. Capital cost system optimization of OTEC power modules 21 p0101 A79-16249
- HORIE, K. Studies on the selective absorption surface on stainless steel 21 p0127 A79-17378
- HORIGOME, T. Solar thermal energy storage using heat of dilution - Analysis of heat generation in multistage mixing column 21 p0046 A79-12271
- Estimation of collector and electrical energy cost for STEPS in Japan 21 p0118 A79-17288
- An analysis of a cylindrical parabolic focussing collector for distributed collector power system 21 p0134 A79-17442
- HORN, H. Uncoupling of economic growth and energy consumption - A new strategy of energy politics or only a new slogan 22 p0310 A79-30997
- HORN, R. Improvement of direct-current electrical prospecting methods for the geothermal investigation of the Rhine Graben 21 p0075 A79-14734
- HORNELL, C. Utility fuel cells for biomass fuel 21 p0016 A79-10131
- HORNEB, B. W. Water-cooled gas turbine technology development - Fuels flexibility [ASHE PAPER 79-GT-72] 22 p0307 A79-30536
- HOROWITZ, J. S. OTEC power systems 21 p0101 A79-16248
- HORSFIELD, B. C. Steam raising with low-Btu gas generators and potential for other applications 21 p0072 A79-14690
- HORTON, T. L. O. Parametric analysis of power conversion systems for central receiver solar power generation [ASHE PAPER 78-WA/SOL-2] 21 p0162 A79-19835
- Conceptual design of a solar powered closed-cycle gas turbine electric power generation system [ASHE PAPER 79-GT-43] 22 p0306 A79-30522
- HOSHINO, C. Efficiency studies about Daihatsu engine/electric hybrid system [SAE PAPER 790013] 22 p0314 A79-31352
- HOUGH, R. L. Solar engines - The thermal wheel and beyond 21 p0095 A79-15909
- HOULBERG, W. A. Space-dependent thermal stability of reacting tokamak plasmas 22 p0253 A79-22242

- HOUSHAN, J. J.  
Measurement of heat loss from a heat receiver  
assembly of a Fixed Mirror Solar Concentrator  
21 p0020 A79-10166
- HOVINGE, J.  
Overview of inertial confinement fusion reactor  
designs  
21 p0018 A79-10149  
Electric power from laser fusion - The HYLIFE  
concept  
21 p0030 A79-10249  
Civilian applications of laser fusion  
[UCRL-52349]  
21 p0195 N79-12439
- HOWARD, J. B.  
Role of aromatics in soot formation  
21 p0053 A79-12988
- HOWARD, P.  
Health effects associated with diesel exhaust  
emissions, literature review and evaluation  
[PB-289817/9]  
22 p0364 A79-20727
- HOWARTH, R.  
Environmental impacts of industrial energy systems  
in the coastal zone  
21 p0075 A79-14722
- HOWELL, R. E.  
Heat recovery devices for building HVAC systems  
21 p0073 A79-14697
- HOWERTON, H. T.  
A thermochemical energy storage system and heat pump  
21 p0012 A79-10105
- HOWES, J. E.  
Emissions from pressurized fluidized-bed  
combustion processes  
22 p0261 A79-23640
- HOYT, C. D.  
Energy and input-output analysis  
21 p0115 A79-17223
- HRICAJ, T. M.  
Design study of superconducting magnets for a  
combustion magnetohydrodynamic /MHD/ generator  
21 p0084 A79-15305  
Fabrication and assembly considerations for a base  
load MHD superconducting magnet system  
22 p0235 A79-20534
- HSIEH, C.-L.  
A calculation of linear magnetic liner fusion  
reactor performance  
21 p0018 A79-10153
- HSU, C. T.  
Some flow analyses for Tornado-type wind turbines  
22 p0279 A79-26181
- HSU, G.  
Electricity from sunlight  
21 p0065 A79-14116
- HSU, G. C.  
Coal desulfurization by low-temperature  
chlorinolysis  
21 p0045 A79-12119  
Surfactant-assisted liquefaction of particulate  
carbonaceous substances  
[NASA-CASE-NPO-13904-1]  
21 p0179 N79-11152
- HSU, J. Y.  
Theory of dissipative drift instabilities in  
sheared magnetic fields  
22 p0292 A79-27884
- HSU, Y.-S.  
Grain-boundary edge passivation of GaAs films by  
selective anodization  
21 p0154 A79-18487
- HUANG, B. J.  
Thermal analysis of black liquid cylindrical  
parabolic collector  
22 p0295 A79-28354
- HUANG, I.  
Wind power from a vortex chamber  
22 p0319 A79-31425
- HUANG, T.  
Hot corrosion of Ni-base turbine alloys in  
atmospheres in coal-conversion systems  
22 p0288 A79-27395
- HUANG, Y.-C.  
A superconducting dipole magnet for the UTSI MHD  
Facility  
22 p0235 A79-20533
- HUBBARD, E. L.  
Doublet III  
22 p0290 A79-27667
- HUBBARD, S. J.  
Methods for the control of environmental damage  
caused by mining energy producing materials  
22 p0347 N79-18359
- HUBER, D. A.  
Conceptual design and cost estimate 600 MWe coal  
fired fluidized-bed combined cycle power plant  
21 p0008 A79-10068
- HUCKO, R. E.  
Interagency coal cleaning technology development  
22 p0347 N79-18361
- HUDSON, W. D.  
Identification of wood energy resources in central  
Michigan  
[NASA-CR-158130]  
22 p0347 N79-18424
- HUETTINGER, K. J.  
Methane formation during the hydrogasification and  
the gas phase pyrolysis of defined aromatics  
22 p0265 A79-23829
- HURTNER, D. A.  
Energy economics - A research analysis  
21 p0115 A79-17222
- HUFF, O.  
The oxidation of sulfur dioxide to sulfate  
aerosols in the plume of a coal-fired power plant  
21 p0076 A79-14757
- HUFFMAN, P. M.  
Characteristics of combustion-heated thermionic  
diodes  
21 p0026 A79-10215  
Increasing the efficiency of coal-fired steam  
electric plants with thermionic topping  
21 p0096 A79-15921
- HUFFMAN, R. L.  
Coal gasification and its alternatives  
21 p0071 A79-14679
- HUGHES, R. L.  
Optical analysis of solar facility heliostats  
22 p0296 A79-28360
- HUGHES, R. O.  
Effects of pointing errors on receiver performance  
for parabolic dish solar concentrators  
21 p0020 A79-10167  
Efficiency degradation due to tracking errors for  
point focusing solar collectors  
[ASME PAPER 78-WA/SOL-4]  
21 p0162 A79-19837
- HUGILL, J.  
Review of results from DITE tokamak  
21 p0069 A79-14456
- HULL, E. J.  
Experience gained and lessons learned from  
monitoring the solar building, Albuquerque  
21 p0088 A79-15833
- HULL, W. C.  
Analysis of a Cassegrain solar furnace  
22 p0293 A79-28147
- HUMENIK, P. M.  
Parametric performance of a turbojet engine  
combustor using jet A and A diesel fuel  
[NASA-TN-79089]  
22 p0357 N79-20114
- HUMMEL, R. L.  
A cost effective vertical air/water solar heating  
collector  
22 p0320 A79-31430
- HUNDERMANN, A. S.  
Electric automobiles. Citations from the NTIS  
data base  
[NTIS/PS-78/0880/1]  
21 p0171 N79-10363  
Electric automobiles, volume 2. Citations from  
the engineering index data base  
[NTIS/PS-78/0881/9]  
21 p0172 N79-10364  
Energy conservation: Policies, programs and  
general studies. A bibliography with abstracts  
[NTIS/PS-78/0693/8]  
21 p0176 N79-10552  
Solar ponds. Citations from the NTIS data base  
[NTIS/PS-78/0836/3]  
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Solar ponds. Citations from the engineering index  
data base  
[NTIS/PS-78/0837/1]  
21 p0176 N79-10554  
Solar energy concentrator design and operation.  
Citations from the NTIS data base  
[NTIS/PS-78/0838/9]  
21 p0178 N79-10566  
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bibliography with abstracts  
[NTIS/PS-78/0961/9]  
21 p0191 N79-11552  
Energy policy and research planning, volume 3. A  
bibliography with abstracts  
[NTIS/PS-78/0962/7]  
21 p0191 N79-11553

- Solar space heating and air conditioning, volume 2. Citations from the NTIS data base [NTIS/PS-78/1014/6] 21 p0211 N79-13545
- Solar space heating and air conditioning volume 3. Citations from the NTIS data base [NTIS/PS-78/1015/3] 21 p0211 N79-13546
- Solar space heating and air conditioning, volume 3. Citations from the engineering index data base [NTIS/PS-78/1017/9] 21 p0211 N79-13547
- Solar space heating and air conditioning, volume 2. Citations from the engineering index data base [NTIS/PS-78/1016/1] 21 p0212 N79-13550
- Flat plate solar collector design and performance. Citations from the NTIS data base [NTIS/PS-78/0840/5] 21 p0212 N79-13551
- Solar electric power generation, volume 2. Citations from the NTIS data base [NTIS/PS-78/1108/6] 21 p0212 N79-13557
- Solar electric power generation, volume 2. Citations from the Engineering Index data base [NTIS/PS-78/1109/4] 21 p0212 N79-13558
- Combined cycle power generation. Citations from the NTIS data base [NTIS/PS-78/1156/5] 21 p0222 N79-14587
- Combined cycle power generation. Citations from the Engineering Index data base [NTIS/PS-78/1157/3] 21 p0222 N79-14588
- Solar water pumps. Citations from the Engineering Index data base [NTIS/PS-78/1288/6] 22 p0343 N79-17348
- HUNDERI, O.  
Selective absorption of solar energy in ultrafine metal particles - Model calculations 22 p0273 A79-25746
- HUNG, J. C.  
Accuracy analysis of pointing control system of solar power station [NASA-CR-150880] 21 p0215 N79-14143
- HUNKE, R. W.  
Preliminary design of the solar total energy-large scale experiment at Shenandoah, Georgia 21 p0019 A79-10159
- HUNN, B. D.  
Analysis and design of solar buildings using the Cal-ERDA computer programs 21 p0137 A79-17463
- Case history - Hybrid passive/active solar system: Performance and cost 22 p0313 A79-31315
- Verification methodology for the DOE-1 building energy analysis computer program [LA-UR-78-1493] 21 p0208 N79-13520
- Component-based simulator for solar systems [LA-UR-78-1494] 21 p0208 N79-13521
- HUNNICUTT, C. L.  
An operating 200 kW horizontal axis wind turbine 22 p0240 A79-20829
- An operating 200-kW horizontal axis wind turbine [NASA-TN-79034] 22 p0333 N79-16357
- HUNSCHE, U.  
Magnetotelluric and geoelectric measurements for geothermal exploration in the Phlegraean Fields /preliminary results/ 21 p0075 A79-14732
- HUNT, A. J.  
The circumsolar measurement program - Assessment of the effects of atmospheric scattering on solar energy conversion 21 p0082 A79-15077
- HUNT, T. E.  
Research on the sodium heat engine 21 p0028 A79-10231
- HUNTER, H. W., II  
Solar power satellites - The laser option 22 p0284 A79-26599
- HURTER, D.  
Recommended performance standards for electric and hybrid vehicles [SAB/1335-1] 21 p0195 N79-12450
- HUSSAIN, I. H.  
Availability of solar energy at Baghdad, Iraq - Performance and design data for flat plate collectors 21 p0133 A79-17428
- HUSSEINY, A. A.  
A multivariate-utility approach for selection of energy sources 21 p0098 A79-16120
- HUSSHAW, E.  
Reduction of the heat loss flux of collectors by infrared reflecting coatings on cover plates 21 p0058 A79-13649
- HUSSON, J. C.  
High accuracy off-shore position finding using the GEOLE satellite based system 22 p0329 N79-15932
- HUTCHINS, F. P.  
Investigation of turbo-dyne energy chamber (G:R: value trademark): An air bleed device [PB-285381/0] 21 p0217 N79-14397
- HUTCHINSON, D. P.  
Effect of the magnetic configuration of the poloidal diverter on the plasma in the T-12 finger-ring tokamak 22 p0244 A79-21429
- HWANG, H. H.  
Control of wind turbine generators connected to power systems 21 p0086 A79-15574
- HYMAN, E. A.  
Battery Energy Storage Test (BEST) Facility. Phenomenological cell modeling: A tool for planning and analyzing battery testing at the BEST facility [COO-2857-1] 21 p0184 N79-11490
- IACHETTA, F. A.  
Annual collection and storage of solar energy for the heating of buildings 21 p0131 A79-17415
- IAKOVLENKO, S. I.  
Direct conversion of solar energy into laser radiation 22 p0311 A79-31086
- IAKUBOV, I. T.  
The electric conductivity of a plasma of combustion products of hydrocarbon fuels with alkali impurity 21 p0167 A79-20415
- IANNUCCI, J. J.  
Energy storage requirements for autonomous and hybrid solar thermal electric power plants 21 p0120 A79-17315
- IAZKULYEV, A.  
Study of the spectral characteristics of metallized polymer films for production of solar concentrators 22 p0297 A79-28672
- IBRAHIM, A.  
Research on the physical properties of geothermal reservoir rock [COO-2908-4] 22 p0358 N79-20459
- IBRAHIM, M.  
Design of solar energy concentrators for power generation in residential and nonresidential areas 21 p0136 A79-17460
- ICERHAN, L.  
Industrial cogeneration - Problems and promise 22 p0265 A79-24047
- ICOVI, M.  
On the possibility of using silver salts other than Ag<sub>2</sub>CrO<sub>4</sub> in organic lithium cells 22 p0246 A79-21491
- IDZOREK, J. J.  
Subsonic diffusers for MHD generators 22 p0279 A79-26185
- IGEL, E. A.  
Optical analysis of solar facility heliostats 22 p0296 A79-28360
- IGNATIEV, A.  
The dependence of optical properties on the structural composition of solar absorbers - Gold black 22 p0242 A79-21162
- Microstructure dependence of the optical properties of solar-absorbing black chrome 22 p0256 A79-22858
- IGHIZIO, J. P.  
Water/energy management and evaluation model for Pennsylvania [PB-287577/1] 22 p0343 N79-17353
- IGRA, O.  
Cost-effectiveness of the vortex-augmented wind turbine 22 p0266 A79-24048



- IIDA, H.  
Efficiency studies about Daihatsu engine/electric hybrid system  
[SAE PAPER 790013] 22 p0314 A79-31352
- IKEDA, R.  
Progress in batteries and solar cells. Volume 1 21 p0148 A79-17989
- IKESAKI, K.  
Rotating strength of glass-carbon fiber-reinforced hybrid composite discs 21 p0165 A79-20273
- ILES, P. A.  
Silicon solar cell process development, fabrication and analysis  
[NASA-CR-158363] 22 p0359 A79-20485
- ILIEV, I.  
Influence of the electrolyte content of oxygen carbon gas-diffusion electrodes on their electro-chemical performance in acid solutions 22 p0245 A79-21483
- ILIN, V. S.  
Laser measurements of the radial profiles of the electron temperature and density in the FT-1 tokamak 22 p0244 A79-21430
- IN, K.  
Slag deposition and its effect on the performance of MHD channels  
[AIAA PAPER 79-0189] 21 p0157 A79-19588
- INBERT, B.  
Solar thermal conversion installations in the medium power range - The Thek project 22 p0254 A79-22269
- INALL, E. K.  
Homopolar generator energy storage for fusion reactors 22 p0304 A79-29942
- INGHAM, J. D.  
Dual membrane hollow fiber fuel cell and method of operating same  
[NASA-CASE-WFO-13732-1] 21 p0172 A79-10513
- INGLEY, H. A.  
The design and evaluation of a hydraulic-solar powered tracking device 21 p0136 A79-17458  
Theoretical basis and design for a residential size solar powered ammonia/water absorption air conditioning system 21 p0139 A79-17479  
An experimental evaluation of an intermittent cycle solar-powered ammonia/water absorption air conditioning system 21 p0139 A79-17481
- INGLIS, D. R.  
Wind power and other energy options 21 p0153 A79-18346
- INHABER, H.  
Risk with energy from conventional and nonconventional sources 22 p0266 A79-24151
- INNOCENTI, F.  
Shallow magmatic reservoirs as heat source of geothermal systems - Preliminary interpretation of data available for the Neapolitan active volcanic areas 21 p0075 A79-14727
- INOUE, M.  
200-kv Blumlein transmission line for ultrafast toroidal theta-pinch 22 p0297 A79-28917
- INOUSHI, Y.  
Ga<sub>1-x</sub>Al<sub>x</sub>/As-GaAs photovoltaic cells with multilayer structure 22 p0305 A79-30258
- IPPOLITO, L.  
Fiat Research Center hybrid vehicle prototype  
[SAE PAPER 790014] 22 p0313 A79-31351
- IQBAL, K. Z.  
Hydrocarbon working fluid and operating conditions selection for the conventional geothermal binary cycle 21 p0015 A79-10124
- IQBAL, M.  
Hourly vs daily method of computing insolation on inclined surfaces 22 p0242 A79-21164  
Optimum collector slope for residential heating in adverse climates 22 p0263 A79-23761
- IRETON, V. H.  
Domestic water preheating using solar energy 22 p0321 A79-31437
- IRVINE, S. J. C.  
The effect of induced disorder on the hydrogenation behaviour of the phase ZrCo 22 p0251 A79-21707
- ISAAC, J. J.  
Cycle optimization for a solar turbopack 21 p0141 A79-17500
- ISAACS, B. S.  
Hydrogen production from high temperature electrolysis and fusion reactor 21 p0015 A79-10126  
Electrochemical characteristics of ZrO<sub>2</sub>-Y<sub>2</sub>O<sub>3</sub> solid electrolytes for fuel cells 21 p0039 A79-11813
- ISAACS, M. P.  
Energy scenarios: Supplementary studies  
[NP-23292] 21 p0211 A79-13543
- ISAKOVA, M. P.  
Subsonic flow in the channel of an MHD-generator 21 p0167 A79-20413
- ISENBERG, A. O.  
Growth of refractory oxide layers by electrochemical vapor deposition /EVD/ at elevated temperatures 21 p0039 A79-11812  
Thin film high temperature solid electrolyte fuel cells 21 p0040 A79-11820
- ISHIBASHI, T.  
Studies on the selective absorption surface on stainless steel 21 p0127 A79-17378
- ISHIKAWA, H.  
Effects of position of output electrodes in entrance region of open-cycle diagonal type MHD generator 21 p0153 A79-18468
- ISHIZAKI, Y.  
The utilization of LH<sub>2</sub> and LNG cold for generation of electric power by a cryogenic-type Stirling engine 22 p0311 A79-31020
- ISSAACS, G. A.  
EPA program conference report: Coal cleaning, an option for Increased Coal Utilization  
[PB-288223/1] 22 p0344 A79-17378
- ITO, E.  
A digital control system for superconducting magnet 22 p0268 A79-24508
- ITOH, S.  
Flywheel energy storage system for JT-60 toroidal field coil 21 p0112 A79-16729
- ITOH, T.  
Solar heating performance of the Toshiba Solar House No. 1 21 p0137 A79-17465
- IUFEROV, V. B.  
Problems in the use of cryogenic pumps in thermonuclear synthesis 22 p0305 A79-30264
- IUN, G. M.  
A problem of optimizing the setting angle of sun-battery panels of concave shape 21 p0045 A79-12186  
Determining optimal angles of nonconvex solar battery panel mounting 21 p0080 A79-14837
- IUNUSOV, M.  
Calculating the photocurrent and maximum efficiency of film p-CdTe-n-CdS photocells 21 p0166 A79-20354
- IURIN, E. M.  
Solar-to-thermal energy converter based on coaxial evacuated tubular elements with multilayer and selective coatings 21 p0167 A79-20356
- IURINSKII, V. T.  
Ways of improving steam-gas power plants 22 p0299 A79-29298
- IUROV, S. S.  
Experimental study of the characteristics of heat and mass transfer in a two-component low-temperature heat pipe 22 p0246 A79-21585

- IVANOFF, R.  
The application of solar thermoelectric generators  
in near-sun missions 21 p0023 A79-10187
- IVANOV, D. P.  
Cryogenic technology and superconductivity in  
controlled fusion 22 p0311 A79-31003
- IVANOV, N. V.  
Experiments on controlling the plasma density in  
the TO-1 tokamak 22 p0324 A79-31762
- IVES, C.  
New approaches for the appropriate use of solar  
energy in northern climates 22 p0319 A79-31424
- IYMKARAN, K.  
Cost effective optimum design of solar air heaters 21 p0127 A79-17386
- IZARD, J.-L.  
Solar energy diagrams 22 p0253 A79-22267
- IZVOZCHIKOV, A. B.  
Properties of the plasma ions and the particle  
lifetime in ohmic heating in the L-2 stellarator 22 p0244 A79-21428

## J

- JACKSON, D. H.  
SRC-II - Review of development and status 21 p0092 A79-15887
- JACKSON, R.  
Managing oil and gas activities in coastal  
environments [PB-283677/3] 21 p0199 A79-12576
- JACKSON, T. A.  
Evaluation of future jet fuel combustion  
characteristics [AD-A060218] 21 p0216 A79-14231
- JACOB, A.  
Control strategy for a variable-speed wind energy  
conversion system 22 p0303 A79-29800
- JACOB, I.  
Hydrogen sorption properties in binary and  
pseudobinary intermetallic compounds 22 p0250 A79-21702
- JACOBS, B.  
Analysis of radioactive contaminants in  
by-products from coal-fired power plant operations  
[PB-286365/2] 21 p0232 A79-15473
- JACOBS, J. K.  
Electronic states of concentrated Pd-H alloys from  
de Haas-van Alphen measurements 22 p0248 A79-21686
- JACOBS, H. R.  
Considerations in choosing solar energy monitoring  
systems 21 p0087 A79-15831
- JACOBS, R. B.  
Cryogenic pellets for laser-fusion research -  
Theoretical and practical considerations 21 p0085 A79-15334
- Point-contact conduction-cooling technique and  
apparatus for cryogenic laser fusion pellets 21 p0085 A79-15335
- JACOBSON, H. R.  
New instrumentation for high temperature and  
hemispherical measurements of selective surfaces 22 p0294 A79-28152
- JACOBSON, W. O.  
Performance of a 10 MW geothermal energy  
conversion test facility 21 p0014 A79-10119
- JAEGER, E. P.  
Radial transport in the ELMO Bumpy Torus in  
collisional regimes 22 p0312 A79-31184
- JAGADISH, B. S.  
Optimum tilt for the flat plate collector 21 p0132 A79-17426
- JAIN, A. K.  
Dynamic response of a novel solar water heater 21 p0140 A79-17488
- JAIN, G. C.  
Trends in silicon solar-photovoltaic cells - An  
invited talk 21 p0122 A79-17333

- JAIN, H. C.  
A reflector concentrator modified sterling engine  
unit and an aqua-ammonia absorber gas turbine  
unit for farm power needs 21 p0142 A79-17509
- JAIN, S. C.  
Response of p-n junction solar cells to  
concentrated sunlight and partial illumination 21 p0124 A79-17353
- JAIN, S. V.  
Mechanical energy storage system for a 10 KWe  
solar power pack 21 p0121 A79-17329
- JAIN, V. K.  
Role of high performance solar cells in practical  
photovoltaic systems 21 p0122 A79-17336
- JAKUBOWSKI, A. K.  
Radioisotope-powered free-piston Stirling engine  
for space applications [IAP PAPER 78-02] 21 p0034 A79-11217
- JAMES, L. W.  
High performance GaAs photovoltaic cells for  
concentrator applications [SAND-78-7018] 21 p0187 A79-11521
- JANAI, H.  
Chemical vapor deposited amorphous silicon for use  
in photothermal conversion 22 p0294 A79-28149
- JANDRASI, J. S.  
Power distribution study for a 5-GW space power  
satellite 21 p0002 A79-10026
- JANETZKE, D. C.  
Evaluation of MOSTAS computer code for predicting  
dynamic loads in two-bladed wind turbines  
[AIAA 79-0733] 22 p0298 A79-29007
- Evaluation of MOSTAS computer code for predicting  
dynamic loads in two bladed wind turbines  
[NASA-TN-79101] 22 p0368 A79-21549
- JANSSSEN, H. R.  
Energy conservation and the rural home: Economic  
considerations for the nation and the individual  
[PB-286222/5] 21 p0230 A79-15425
- JARASS, A.  
Stormy development of wind energy 22 p0268 A79-24323
- JARASS, L.  
Stormy development of wind energy 22 p0268 A79-24323
- JASON, A.  
Development of surfaces optically suitable for  
flat solar panels [NASA-CR-150831] 21 p0173 A79-10522
- JASSEY, A.  
Energy technologies and natural environments - The  
search for compatibility 21 p0074 A79-14721
- JASSEY, D. L.  
SLEX - Superconducting Long-Pulse Tokamak Experiment 22 p0237 A79-20557
- JASTREBSKI, L.  
Present status of GaAs [NASA-CR-3093] 21 p0215 A79-14192
- JAUD, P.  
Preliminary results of the new geothermal domestic  
heating system at Creil 21 p0075 A79-14740
- JELDRES, B.  
On the optimisation of Trombe wall solar collectors  
[ASHE PAPER 78-WA/SOL-13] 21 p0163 A79-19845
- JENKINS, D. H.  
Integration of a passive and active solar heated,  
low density, multiple dwelling with atrium 22 p0322 A79-31446
- JENKINS, G. H.  
Form-stable, crystalline polymer pellets for  
thermal energy storage 21 p0013 A79-10107
- JENKINS, J. P.  
Testing of solar collectors according to ASHRAE  
Standard 93-77 21 p0101 A79-16417
- Testing of water-heating collectors according to  
ASHRAE Standard 93-77 21 p0130 A79-17410
- Experimental verification of a standard test  
procedure for solar collectors [PB-289912/8] 22 p0372 A79-21632

## JENKINS, L. H.

A technology program for large area space systems  
21 p0100 A79-16145

## JENKINS, P. E.

Numerical computation of the loss coefficients for  
evacuated cylindrical collector receiver tubes  
[ASME PAPER 78-WA/SOL-3] 21 p0162 A79-19836  
Design of a freon jet pump for use in a solar  
cooling system  
[ASME PAPER 78-WA/SOL-15] 21 p0164 A79-19847  
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Advanced batteries  
21 p0067 A79-14270

## JOBE, C. E.

Large-vehicle concepts  
22 p0306 A79-30485

## JOHNSEN, A. W.

Evaluation of the Ames, Iowa refuse derived fuel  
recovery system  
21 p0064 A79-14115  
Source emissions factors for refuse derived fuels  
21 p0082 A79-15084  
Environmental effects of burning solid waste as fuel  
21 p0082 A79-15115  
Operation and emission of a stoker-fired boiler  
while burning refuse derived fuel and coal  
mixtures  
[ASME PAPER 78-WA/APC-2] 21 p0158 A79-19735

## JOHANSON, E. W.

Fabrication experiences and operating  
characteristics of the U.S. SCNS superconducting  
dipole magnet for MHD research  
21 p0084 A79-15304

## JOHN, V. I.

A Variable Speed Constant Frequency /VSCF/ wind  
generator for low power applications  
22 p0303 A79-29799

## JOHNS, H. D.

Wind power site evaluation. I - Wind energy  
potential. II - Data acquisition and processing  
22 p0257 A79-22924

## JOHNSON, C. A.

An inventory of environmental impact models  
related to energy technologies  
[ORNL/EIS-147] 22 p0372 A79-21640

## JOHNSON, C. E.

Experimental two-phase liquid-metal  
magnetohydrodynamic generator program  
[AD-A059240] 21 p0197 A79-12564

## JOHNSON, D.

The ground water and energy supply situation for  
Great Plains irrigation  
[PB-286002/1] 21 p0222 A79-14586

## JOHNSON, D. G.

New energy from an old source - Hydrogen from  
falling water  
21 p0015 A79-10129

## JOHNSON, E. K.

Commercialization of fluidized-bed combustion  
systems by the State of Ohio  
21 p0096 A79-15923

## JOHNSON, G. E.

Emissions of nitrogen dioxide from a large  
gas-turbine power station  
21 p0152 A79-18344

## JOHNSON, G. R.

A microprocessor based solar controller  
21 p0082 A79-14979

## JOHNSON, H. G.

SLPX - Superconducting Long-Pulse Tokamak Experiment  
22 p0237 A79-20557

## JOHNSON, I.

Factors limiting limestone utilization efficiency  
in fluidized-bed combustors  
21 p0008 A79-10069  
Limestone SO<sub>2</sub> reactivity and causes for reactivity  
loss during multi cycle utilization  
21 p0065 A79-14121

## JOHNSON, L. A.

Oil recovery from a Utah tar sand deposit by in  
situ combustion  
21 p0004 A79-10043

## JOHNSON, H.

Low-temperature application of solar energy in  
South Africa  
22 p0340 A79-17324

## JOHNSON, R. W.

Space solar power - An energy alternative  
22 p0303 A79-29796

## JOHNSON, R., JR.

On-orbit fabrication and assembly of large space  
structural subsystems  
[IAP PAPER 78-192] 21 p0035 A79-11288

## JOHNSON, T. F.

Fluid-bed carbonization/desulfurization of  
Illinois coal by the Clean Coke Process - PDU  
studies  
21 p0045 A79-12121

## JOHNSON, T. E.

Slag transport models for radiant heater of an MHD  
system  
[ASME PAPER 78-WA/HT-21] 21 p0161 A79-19808  
MDH balance of plant technology project  
[ANL-MHD-78-7] 22 p0361 A79-20500

## JOHNSON, V. H.

Sensor selection and placement in the National  
Solar Data Program  
21 p0089 A79-15844

## JOHNSON, W. H.

Advances in lower cost phosphoric acid fuel cells  
21 p0010 A79-10092

## JOHNSTON, R.

Alternatives for coal based power generation - An  
international overview  
21 p0008 A79-10074

## JONCICH, D. H.

Design of solar heating and cooling systems  
[AD-A062719] 22 p0363 A79-20522

## JONES, C.

Rotary engine developments at Curtiss-Wright over  
the past 20 years and review of general aviation  
engine potential  
22 p0329 A79-15967

## JONES, C. B.

An analytical investigation of the performance of  
solar collectors as nighttime heat radiators in  
airconditioning cycles  
[NASA-CR-3111] 22 p0363 A79-20519

## JONES, D. E.

System performance measurements for a packaged  
solar space heating system equipped with  
air-heating collectors  
21 p0088 A79-15835

Testing of solar collectors according to ASHRAE  
Standard 93-77  
21 p0101 A79-16417

Experimental verification of a standard test  
procedure for solar collectors  
[PB-289912/8] 22 p0372 A79-21632

## JONES, G.

Passive solar heating - Results from two  
Saskatchewan residences  
22 p0322 A79-31444

## JONES, J. L.

Preliminary environmental assessment of energy  
conversion processes for agricultural and forest  
product residues, volume 1  
[PB-281189/1] 21 p0178 A79-10574

## JONES, W. A.

Techniques for preventing damage to high power  
laser components  
21 p0083 A79-15145

## JONES, W. H.

Structuring a small national or state solar energy  
program  
22 p0262 A79-23751

## JONES, W. S.

Laser-powered aircraft and rocket systems with  
laser energy relay units  
21 p0109 A79-16619

Laser aircraft  
22 p0284 A79-26597

Solar power satellites - The laser option  
22 p0284 A79-26599

Laser power conversion system analysis, volume 1  
[NASA-CR-159523-VOL-1] 22 p0366 A79-21334

Laser power conversion system analysis, volume 2  
[NASA-CR-159523-VOL-2] 22 p0366 A79-21335

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- JONG, H.**  
A small horizontal axis wind turbine feeding power into the utility grid  
21 p0074 A79-14703
- JONKE, A.**  
Coal liquefaction support studies. Task 1: Heat of reaction of hydrogen with coal slurries.  
Task 2: Heat transfer coefficient  
[ANL/CEB/FE-77-5] 21 p0216 A79-14242
- JORDAN, D.**  
Development of gas turbine performance seeking logic  
[ASME PAPER 78-GT-13] 21 p0031 A79-10257
- JORDAN, J. B.**  
Combustion of droplets and sprays of some alternative fuels  
21 p0052 A79-12983
- JORGENSEN, L. W.**  
Plasma density measurements on refuelling by solid hydrogen pellets in a rotating plasma  
22 p0255 A79-22369
- JOSEPH, H. H.**  
Progress in batteries and solar cells. Volume 1  
21 p0148 A79-17989
- JOSHI, S. P.**  
On the role of interface states in MOS solar cells  
21 p0122 A79-17337
- JOSWIG, G.**  
Gasification of coal with high-temperature reactor heat - Investigations concerning the market and the economics  
22 p0264 A79-23828
- JOUBERT, J. I.**  
Fuels and combustion  
21 p0106 A79-16488
- JUENTGEN, H.**  
Substitute natural gas from coal using high-temperature reactor heat - Project 'Prototype Plant Nuclear Process Heat'  
22 p0264 A79-23827
- JUNG, H.**  
Performance of the Meadowvale solar home  
22 p0318 A79-31420
- JURICIC, D.**  
On the dynamics of electrostatically precipitated fly ash  
[ASME PAPER 78-WA/PU-3] 21 p0160 A79-19787
- JURINAK, J. J.**  
Properties optimization for phase-change energy storage in air-based solar heating systems  
21 p0149 A79-18018
- JURISSON, J.**  
Multicolor solar cell power system for space  
21 p0108 A79-16611
- JUST, C.**  
Evaluation program for new industrial gas turbine materials  
[ASME PAPER 78-GT-145] 21 p0031 A79-10269
- JUSTI, E.**  
Problems, status, and prospects of a solar hydrogen economy  
21 p0059 A79-13658
- Hydrogen production by conventional and modified water electrolysis**  
21 p0059 A79-13659
- Generation of electrical energy from hydrogen and oxygen by means of fuel cells**  
21 p0059 A79-13662
- JUSTIN, B.**  
Performance testing of solar collectors  
21 p0155 A79-18875
- JUSTUS, C. G.**  
Generic power performance estimates for wind turbines  
21 p0068 A79-14295
- Energy statistics for large wind turbine arrays**  
22 p0299 A79-29371
- JUTSEN, J.**  
Energy storage using the reversible oxidation of barium oxide  
22 p0242 A79-21169
- JUZWA, H.**  
Bituminous coal extraction in terms of electron-donor and -acceptor interactions in the solvent/coal system  
22 p0283 A79-26469
- KABALA, S.**  
A low energy scenario for the United States - 1975-2050  
21 p0147 A79-17649
- KABE, A.**  
Superconducting energy storage magnets  
22 p0236 A79-20537
- KACHADORIAN, J.**  
Enhancement of intrinsic solar heating  
21 p0140 A79-17494
- KADLEC, R. A.**  
The development of a laser Doppler velocimetry system for unsteady separated flow research: Preliminary results  
[AD-A061724] 22 p0352 A79-19305
- KADOHTSEV, B. B.**  
Controlled thermonuclear fusion  
22 p0287 A79-27339
- KAENPEN, C. E.**  
Tropospheric conduits  
22 p0266 A79-24275
- KAESTNER, P. C.**  
Solar Irrigation Program Data Base Management System (SIPDBMS)  
[SAND-78-0641] 21 p0209 A79-13532
- KAHLE, R. L.**  
Environmental assessment of solid residues from fluidized-bed fuel processing  
[PB-282940/6] 21 p0179 A79-10968
- KAHN, E.**  
Reliability of wind power from dispersed sites: A preliminary assessment  
[LBL-6889] 21 p0176 A79-10547
- KATNE, M.**  
A hybrid wind turbine suitable for developing regions  
22 p0323 A79-31455
- KAISHEVA, A.**  
Influence of the electrolyte content of oxygen carbon gas-diffusion electrodes on their electro-chemical performance in acid solutions  
22 p0245 A79-21483
- KAJI, I.**  
The formulation of the wall stabilization problem of an axisymmetrical toroidal sharp-boundary plasma with a horizontally elongated noncircular cross section  
22 p0327 A79-32103
- KAJIKAWA, T.**  
Optimum power plant capacity of ocean-based ocean thermal energy conversion systems  
22 p0297 A79-28922
- KAKAC, S.**  
Solar-hydrogen energy system and solar-hydrogen production methods  
21 p0104 A79-16463
- KAKHAROV, B. A.**  
Study of the temperature distribution across the width of the screen of low-temperature water heaters with tubular heat receivers  
22 p0297 A79-28671
- KAKURIN, A. H.**  
Experiments on controlling the plasma density in the TO-1 tokamak  
22 p0324 A79-31762
- KALAC, S.**  
Thermal storage of solar energy  
21 p0103 A79-16459
- KALADZE, T. D.**  
Cyclotron-wave spectrum in a plasma with two ion species  
22 p0245 A79-21443
- KALINCHAK, A. I.**  
Selection of thermal operating regimes for fuel cell reactor-condenser systems  
21 p0165 A79-20342
- KALMANOVIZ, D.**  
Experiments with a flat plate solar water heating system in thermosyphonic flow  
22 p0262 A79-23755
- KALVINSKAS, J.**  
Bioconversion study conducted by JPL  
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- KALVINSKAS, J. J.  
Coal desulfurization by low-temperature chlorinolysis  
21 p0045 A79-12119
- KAMAT, P. V.  
Direct photoelectrochemical conversion and storage of solar energy  
21 p0126 A79-17370
- KAMIMOTO, H.  
Solar thermal energy storage using heat of dilution - Analysis of heat generation in multistage mixing column  
21 p0046 A79-12271
- KAMİYAMA, S.  
On the flow of a conducting fluid between parallel disks with a transverse magnetic field. I - A theoretical investigation on a nonequilibrium plasma flow as a compressible inviscid fluid  
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The utilization of LH2 and LNG cold for generation of electric power by a cryogenic-type Stirling engine  
22 p0311 A79-31020
- KANAEV, B. I.  
Stabilization of drift loss-cone instability /DCI/ by addition of cold ions  
22 p0291 A79-27882
- KANDLIKAR, S. G.  
Geometrical aspects of a cylindrical parabolic collector  
21 p0134 A79-17443
- KANG, C. C.  
Catalyst evaluation for denitrogenation of petroleum residua and coal liquids, phase 5 [PB-287180/4]  
22 p0339 N79-17026
- KANTAK, A. V.  
Automatic phase control in solar power satellite systems [NASA-CR-151856]  
21 p0194 N79-12130
- KANTSIOS, A. G.  
Detection of internal defects in a liquid natural gas tank by use of infrared thermography  
21 p0048 A79-12507
- KAPLAN, E.  
Assessment of the solid waste impact of the National Energy Plan [BNI-50708]  
21 p0213 N79-13572
- KAPLAN, E. H.  
Space Shuttle - America's wings to the future  
21 p0114 A79-17124
- KAPLOW, B.  
Performance of a new high-intensity silicon solar cell  
22 p0257 A79-22862
- KAPUR, J. C.  
A passive integrated unit for the collection, thermal storage in fusion materials and distribution of solar energy for home heating and other applications  
21 p0121 A79-17322  
A heat operated mechanical device to control the temperature and flow of water entering a hot water storage tank in a solar water heating system  
21 p0140 A79-17487
- KAPUR, V.  
Novel duplex vapor electrochemical method for silicon solar cells [NASA-CR-158039]  
21 p0218 N79-14537
- KAPUR, V. K.  
Investigation on the feasibility of using a two-phase thermosyphon for solar storage, space heating and cooking  
21 p0121 A79-17330
- KAR, S.  
On the role of interface states in MOS solar cells  
21 p0122 A79-17337  
On the role of interface states in MOS solar cells  
21 p0156 A79-19092
- KARAPPA, H.  
Air quality assessment of particulate emissions from diesel-powered vehicles [PB-286172/2]  
21 p0223 N79-14641
- KARAKI, S.  
Instrumentation, data acquisition and monitoring system for an air heating solar system  
21 p0088 A79-15836  
Estimation of collector and electrical energy cost for STEPS in Japan  
21 p0118 A79-17288
- Space heating with solar all-air systems - CSU Solar House II  
21 p0137 A79-17467
- Solar air heating and nocturnal cooling system /CSU Solar House II/  
22 p0275 A79-25932
- KARASAKI, T.  
Operational characteristics of MHD turbine with air-core superconducting rotor  
22 p0297 A79-28924
- KARGIN, P. E.  
Ways of improving steam-gas power plants  
22 p0299 A79-29298
- KARHANAVALA, N. D.  
Direct photoelectrochemical conversion and storage of solar energy  
21 p0126 A79-17370
- KARNECK, J.  
Methodology for modeling geothermal district heating for residential markets [BNL-50905]  
22 p0361 N79-20502
- KARLSSON, B.  
Colored stainless steel - A new type of selective absorber  
22 p0294 A79-28150
- KARLSSON, G.  
Utility fuel cells for biomass fuel  
21 p0016 A79-10131
- KARPOKHIN, A. V.  
Channel No. 1 of the MHD generator of a U-25B unit for carrying out investigations in strong electric and magnetic fields  
21 p0049 A79-12693
- KARTTUNEN, S. J.  
Effects of nonlinear decay of backscattered light on the anomalous reflectivity  
22 p0310 A79-30742
- KASATKIN, V. V.  
Characteristics of silicon photoconverters with inversion layer  
21 p0166 A79-20349
- KASHEMAN, D. L.  
A methodological note on the evaluation of new technologies - The case of coal gasification  
21 p0099 A79-16122
- KASHKARI, C.  
Input-output method applied to energy planning  
21 p0112 A79-16737
- KASS, W. J.  
Acoustic emissions during hydride formation  
22 p0249 A79-21691
- KASSEL, S.  
Pulsed-power research and development in the USSR [AD-A056635]  
21 p0193 N79-11859
- KASSING, D.  
Energy for Europe from space  
22 p0273 A79-25605
- KATANIA, N. D.  
Temperature dependence of photovoltaic solar energy conversion for GaAs homojunction solar cell  
22 p0256 A79-22768
- KATJANI, A.  
Photovoltaic effect in metal-insulator-semiconductor structure  
21 p0123 A79-17343
- KATSELSOON, S. S.  
Nonstationary two-dimensional magnetohydrodynamic flow in a radial channel  
22 p0247 A79-21626
- KATSURAI, M.  
Operational characteristics of MHD turbine with air-core superconducting rotor  
22 p0297 A79-28924
- KATTER, L. B.  
Applications of thermal energy storage to process heat and waste heat recovery in the iron and steel industry [NASA-CR-159397]  
21 p0183 N79-11473
- KATZ, E.  
Effect of noncondensable gases on geothermal power generation  
21 p0015 A79-10125
- KATZ, J. J.  
Biomimetic approach to solar energy conversion - Artificial photosynthesis  
21 p0094 A79-15899  
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21 p0186 N79-11506

- KATZ, R.  
Analysis of electrolyte shunt currents in fuel cell powerplants 21 p0039 A79-11816
- KAU, C. J.  
The fate of fuel nitrogen - Implications for combustor design and operation 21 p0080 A79-14927  
Low NOx combustion concepts for advanced power generation systems firing low-Btu gas [PB-282983/6] 21 p0178 N79-10610
- KAUFFMAN, K. W.  
Residential and commercial thermal storage 21 p0090 A79-15865
- KAUFMAN, B. L.  
Co-disposal of sewage sludge using refuse-derived fuel 21 p0097 A79-16098
- KAUB, T. D.  
Advances in the development of lithium-aluminum/metal sulfide cells for electric-vehicle batteries 21 p0010 A79-10089
- KAUSHIK, S. C.  
Periodic heating/cooling by solar radiation 21 p0140 A79-17491
- KAW, P. K.  
Theory of dissipative drift instabilities in sheared magnetic fields 22 p0292 A79-27884
- KAWADA, Y.  
Solar heating performance of the Toshiba Solar House No. 1 21 p0137 A79-17465
- KAWAKATSU, S.  
Efficiency studies about Daihatsu engine/electric hybrid system [SAE PAPER 790013] 22 p0314 A79-31352
- KAY, R. K.  
Convective effects in 'slat collectors' 21 p0129 A79-17400
- KAYSER, H.  
Wave driven power generating system 21 p0059 A79-13657
- KAZA, K. B. V.  
Evaluation of MOSTAS computer code for predicting dynamic loads in two-bladed wind turbines [AIAA 79-0733] 22 p0298 A79-29007  
Evaluation of MOSTAS computer code for predicting dynamic loads in two bladed wind turbines [NASA-TN-79101] 22 p0368 N79-21549
- KEAINE, D. L.  
Circulating-bed boiler concepts for steam and power generation 21 p0008 A79-10071
- KEANE, E. J.  
Optimal control of on-board and station flywheel storage for rail transit systems 21 p0148 A79-17822  
Optimal control of on-board and station flywheel storage for rail transit systems [ASME PAPER 78-WA/DSC-32] 21 p0159 A79-19771  
The application of optimal control theory hybrid electric transit systems [AD-A059365] 21 p0220 N79-14559
- KEARNEY, D. W.  
Demonstration and commercial prototype tokamak reactors 21 p0018 A79-10146
- KEAST, D. W.  
Noise-control needs in the developing energy technologies [COO-4389-1] 21 p0213 N79-13569
- KEATING, E. L.  
Quasi-equilibrium Air Standard heat balanced cycle analysis 21 p0028 A79-10232
- KEDL, R. J.  
Thermal energy storage for industrial waste heat recovery 21 p0012 A79-10101
- KEEHL, T. S.  
Tests of Wisconsin S12D engine running on natural gas with addition of carbon dioxide [AD-A058486] 22 p0339 N79-17230
- KEEWAN, B. R.  
Energy and environment: An intergovernmental perspective [PB-283733/4] 21 p0198 N79-12575
- KEHL, A.  
The Tritium test house 22 p0290 A79-27723
- KEILACKER, H.  
Magnetic divertors 21 p0078 A79-14781
- KEILIN, V. E.  
Cryogenic technology and superconductivity in controlled fusion 22 p0311 A79-31003
- KEISCH, B.  
Moessbauer spectroscopy of iron in coal and coal hydrogenation products 22 p0282 A79-26464
- KEITH, J. E.  
The impact of energy resource development on water resource allocations [PB-286135/9] 21 p0231 N79-15432
- KEIZER, C. P.  
An electric propulsion system for a town and city bus 22 p0302 A79-29499
- KELLER, L.  
Storage efficiency in a solar plant 22 p0254 A79-22270
- KELLER, L. J.  
Beneficiation of lignites 21 p0146 A79-17642
- KELLOGG, H. H.  
Toward a materials-conservation ethic 21 p0167 A79-20438
- KELLY, P. G.  
Design features of the TDRSS solar array 21 p0002 A79-10019
- KELLY, B. H.  
Recent advances in convectively cooled engine and airframe structures for hypersonic flight 21 p0165 A79-20087
- KENAHAN, C. B.  
Energy use patterns for metal recycling [PB-284855/4] 21 p0201 N79-13152
- KENNEDY, C. J.  
Frequency doubling of a solar pumped Nd:YAG laser 21 p0044 A79-12062
- KENNEDY, W. K.  
Plans and prospects for solar energy utilisation in Malawi 21 p0117 A79-17285
- KERNODE, R. I.  
Synthetic oil from coal - The economic impact of five alternatives for making hydrogen from coal and steam 22 p0262 A79-23719  
Wilson parameters for the system H<sub>2</sub>, N<sub>2</sub>, CO, CO<sub>2</sub>, CH<sub>4</sub>, H<sub>2</sub>S, C<sub>2</sub>H<sub>6</sub>, and H<sub>2</sub>O 22 p0282 A79-26462  
The economics of hydrogen and carbon monoxide separation with cuprous ammonium lactate solutions 22 p0299 A79-29313
- KERR, R. G.  
The performance of a site built, air heating, vertical collector with snow reflector in Quebec 22 p0319 A79-31423  
Validation of an electric circuit model of a solar house 22 p0321 A79-31440
- KERSTEN, R.  
The Philips experimental house - A system's performance study 22 p0277 A79-25941
- KERTZ, W.  
Magnetotelluric and geoelectric measurements for geothermal exploration in the Phlegraean Fields /preliminary results/ 21 p0075 A79-14732
- KESSLER, G.  
Energy for the long run - Fission or fusion 22 p0256 A79-22760
- KESSLER, H. J.  
The ClearView Solar Collector system and associated one and two stage evaporative cooling - Interim results [AIAA PAPER 78-1759] 21 p0061 A79-13860
- KESSLER, H. K.  
Measurement techniques for solar cells [PB-287519/3] 22 p0343 N79-17352
- KESSLER, R.  
MHD power generation 21 p0146 A79-17638

## KESTIN, J.

- Geothermal preheating in fossil-fired steam power plants 21 p0014 A79-10118  
 Fossil superheating in geothermal steam power plants 21 p0014 A79-10122  
 Hybrid fossil-geothermal power plants 21 p0096 A79-15920

## KETTANI, H. A.

- Solar electricity production 21 p0104 A79-16467  
 Solar pumping 21 p0104 A79-16469

## KHALIFA, H. E.

- Geothermal preheating in fossil-fired steam power plants 21 p0014 A79-10118  
 Fossil superheating in geothermal steam power plants 21 p0014 A79-10122  
 Hybrid fossil-geothermal power plants 21 p0096 A79-15920

## KHALIL, T. S.

- The economics and policy of alternative energy sources - A review 21 p0103 A79-16454

## KHANDANI, S. H. H.

- A Thermic Controller for a thermic diode solar panel [ASME PAPER 78-WA/SOL-9] 21 p0163 A79-19841

## KHANDLWAL, G. S.

- Elemental characteristics of aerosols emitted from a coal-fired heating plant [NASA-TM-78749] 21 p0191 N79-11560

## KHATTAK, C. P.

- Silicon sheet growth development for the large area sheet task of the low cost solar array project. Heat exchanger method - ingot casting fixed abrasive method - multi-wire slicing [NASA-CR-158038] 21 p0219 N79-14540

## KHEYRANDISH, K.

- Design considerations of small solar collector systems using plane heliostats [ASME PAPER 79-SOL-2] 22 p0307 A79-30540

## KHINCHENKO, L. N.

- Effect of the magnetic configuration of the poloidal diverter on the plasma in the T-12 finger-ring tokamak 22 p0244 A79-21429

## KHODZHAV, A. SH.

- Composite heliostats of large solar plants 21 p0166 A79-20350

## KHOLEVA, H.

- Study of the spectral characteristics of metallized polymer films for production of solar concentrators 22 p0297 A79-28672

## KHOLMOV, I. V.

- Properties of the plasma ions and the particle lifetime in ohmic heating in the L-2 stellarator 22 p0244 A79-21428

## KHOLOD, I. V.

- Problems in the use of cryogenic pumps in thermonuclear synthesis 22 p0305 A79-30264

## KHOURY, G.

- The Sunship 22 p0254 A79-22324

## KHUDOLEV, A. V.

- Properties of the plasma ions and the particle lifetime in ohmic heating in the L-2 stellarator 22 p0244 A79-21428

## KHUONG, C. H.

- Energy conservation through source reduction [PB-290126/2] 22 p0372 N79-21626

## KICHAYVA, G. S.

- Problems in the development of high-service-life capacitive accumulators 22 p0243 A79-21249

## KILGORE, J. D.

- EPA program conference report: Coal cleaning, an option for increased coal utilization [PB-288223/1] 22 p0344 N79-17378  
 Interagency coal cleaning technology development 22 p0347 N79-18361

## KILROY, W. P.

- Differential scanning calorimetry studies of possible explosion-causing mixtures in Li/SO<sub>2</sub> cells 22 p0246 A79-21487

## KIM, B. T.

- Synthetic oil from coal - The economic impact of five alternatives for making hydrogen from coal and steam 22 p0262 A79-23719

## KIM, J. K.

- Reliability studies on MIS solar cells 21 p0148 A79-17950

## KIM, S. B.

- Pabrication experiences and operating characteristics of the U.S. SCMS superconducting dipole magnet for MHD research 21 p0084 A79-15304

## KIMPREHAUS, W.

- Solar water heating [BHPT-PB-T-77-42] 22 p0349 N79-18457

## KINURA, K.

- Plywheel energy storage system for JT-60 toroidal field coil 21 p0112 A79-16729

## KINURA, K.-I.

- Comparison between simulation and experiment of solar heating 21 p0137 A79-17461

## KING, J. R.

- Parameters for legislative consideration of bioconversion technologies [PB-284742/4] 21 p0194 N79-12250

## KING, R.

- Diffuse solar radiation on a horizontal surface for a clear sky 22 p0242 A79-21167  
 Direct solar transmittance for a clear sky 22 p0296 A79-28361

## KING, R. T.

- Failure analysis in coal conversion systems 22 p0266 A79-24137

## KINKHEAD, W. K.

- Coal desulfurization using microwave energy [PB-285880/1] 21 p0216 N79-14243

## KINNOOD, S.

- The interfacial layer in MIS amorphous silicon solar cells 22 p0258 A79-23039

## KINNEY, C.

- Coal-fired gas turbine power cycles with steam injection 21 p0004 A79-10042

## KINNEY, C. A.

- Cogeneration in Europe and the combined cycle gas turbine 22 p0297 A79-28988

## KINOSHITA, K.

- Effects of sintering on porous fuel cell electrodes 21 p0039 A79-11818

## KIPP, P.

- Practical applications of silicon solar cells in appliances and installations 21 p0057 A79-13638

## KIRCHHOFF, R. B.

- The interaction of the wind field with a horizontal axis wind turbine 22 p0278 A79-26177  
 A two dimensional vortex sheet model of a Savonius Rotor 22 p0278 A79-26178

## KIRILLIN, V. A.

- U-25B MHD unit for carrying out investigations under the conditions of strong electric and magnetic fields 21 p0049 A79-12692

## KIRILLOV, I. R.

- Calculation and design of liquid-metal MHD induction machines 22 p0286 A79-27302

## KIRILLOV, I. O.

- Dynamic characteristics of a free-piston diesel engine combined with a MHD generator 22 p0258 A79-23137

## KIRKLIN, D. R.

- Test procedures for the determination of the gross caloric value of refuse and refuse-derived-fuels by oxygen bomb calorimetry: Summary of the 1977 fiscal year results [PB-290160/1] 22 p0364 N79-21167

## KIRKPATRICK, A. R.

- Integral assembly of photovoltaic arrays using glass 22 p0241 A79-20883

## PERSONAL AUTHOR INDEX

KOCH, B.

- KIRKPATRICK, R. C.  
An overview of design space for small fusion targets  
22 p0253 A79-22241
- KIRKWOOD, P.  
Non-electric applications of geothermal energy in  
six Alaskan towns  
[IDO-1622-4] 21 p0208 N79-13523
- KIRTLEY, J. L., JR.  
MIT-DOE program to demonstrate an advanced  
superconducting generator  
22 p0236 A79-20549
- KISREV, V. M.  
Design of a heat pipe with separate channels for  
vapor and liquid  
22 p0268 A79-24486
- KISHIMOTO, H.  
Flywheel energy storage system for JT-60 toroidal  
field coil  
21 p0112 A79-16729
- KISKO, W. A.  
Evolution of space power systems  
[IAF PAPER 78-43] 21 p0035 A79-11218
- KISLIAKOV, A. I.  
Recombination-induced neutral-particle flux in  
tokamaks  
22 p0291 A79-27877
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Proceedings. Parts 1 & 2  
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- KITA, J. P.  
Wind turbine generator application places unique  
demands on tower design and materials  
22 p0240 A79-20826
- KITO, M.  
The formulation of the wall stabilization problem  
of an axisymmetrical toroidal sharp-boundary  
plasma with a horizontally elongated noncircular  
cross section  
22 p0327 A79-32103
- KITTLAUS, E. R.  
Controlling a wind generator for increased  
efficiency  
21 p0113 A79-16743
- KITTLESON, K.  
Identification of wood energy resources in central  
Michigan  
[NASA-CR-158130] 22 p0347 N79-18424
- KLAN, M. S.  
Financial/management scenarios for a satellite  
power system program  
[AAS PAPER 78-144] 22 p0243 A79-21259
- KLASS, D. L.  
Biomass and wastes as energy resources - 1977 update  
21 p0091 A79-15868
- KLATT, K. H.  
The use of FeTi-hydride for production and storage  
of suprapure hydrogen  
22 p0250 A79-21700
- KLECKNER, E. W.  
Differential insolation and turbidity measurements  
22 p0241 A79-21056
- KLEIN, J. W.  
No ill winds for New Mexico utility  
22 p0286 A79-27208
- KLEIN, H. G.  
Fabrication and testing of silver-hydrogen cells  
[NASA-CR-159431] 22 p0334 N79-16374
- KLEIN, S. A.  
Calculation of flat-plate collector utilizability  
21 p0149 A79-18020  
A general design method for closed-loop solar  
energy systems  
22 p0295 A79-28359
- KLEIN, W. H.  
Flat plate collector dynamic evaluation  
21 p0128 A79-17390
- KLEINER, C. T.  
Power distribution study for a 5-GW space power  
satellite  
21 p0002 A79-10026
- KLEINSCHNAGER, H.  
Development of high temperature fuel cell battery  
[BNFT-FE-1-77-17] 22 p0342 N79-17344
- KLEINWACHTER, B.  
Development of solar collectors for low  
temperature level and of concentrators for  
thermal and photoelectric conversion  
21 p0135 A79-17445
- KLENN, H. A.  
A model for coal fly ash filtration  
22 p0296 A79-28389
- KLEPPA, O. J.  
High temperature thermodynamics of the solid  
solutions of hydrogen and deuterium in palladium  
and in the Pd/0.9/Ag/0.1/ alloy  
22 p0249 A79-21689
- KLIER, R.  
Flue gas desulfurization system capabilities for  
coal-fired steam generators, volume 1.  
Executive summary  
[PB-284045/2] 21 p0200 N79-12606
- KLINE, J. H.  
Shock-tube measurements of induction and  
post-induction rates for low-Btu gas mixtures  
21 p0083 A79-15245
- KLINE, R. L.  
Technology and development requirements of the  
solar power satellite  
21 p0046 A79-12267
- KLINEBERG, J. H.  
Technology for aircraft energy efficiency  
21 p0066 A79-14136  
The NASA Aircraft Energy Efficiency program  
22 p0325 A79-31912
- KLINKENBERG, K.  
The Phillips experimental house - A system's  
performance study  
22 p0277 A79-25941
- KLOECKER, E.-J.  
Gasification of raw lignite in the tube-furnace  
gasifier  
22 p0310 A79-30996
- KLUNDER, K.  
Superbatteries - A progress report  
22 p0286 A79-27207
- KNASSEL, T. H.  
System designs for low cost-low ratio solar  
concentrators  
22 p0293 A79-28142
- KNOBLOCH, A. F.  
Superconducting magnet systems in EPR designs  
21 p0079 A79-14789
- KNOEPFEL, H.  
Tokamak reactors for breakeven: A critical study  
of the near-term fusion reactor program  
21 p0077 A79-14776
- KNOTEN, H. L.  
Study of the interaction of H<sub>2</sub>O and O<sub>2</sub> with the  
surface of TiO<sub>2</sub> by electron stimulated  
desorption and Auger and characteristic loss  
spectroscopies  
21 p0037 A79-11793
- KNOTT, G. F.  
Wave-tank experiments on an immersed  
parallel-plate duct  
22 p0258 A79-23306
- KNOWLES, G. B.  
Active heat exchange system development for latent  
heat thermal energy storage  
[NASA-CR-159479] 22 p0368 N79-21554
- KNOX, A. E.  
HYCSOS - A system for evaluation of hydrides as  
chemical heat pumps  
22 p0252 A79-21716
- KNUTSON, C. F.  
An assessment of subsurface salt water disposal  
experience on the Texas and Louisiana Gulf coast  
for application to disposal of salt water from  
geopressed geothermal wells  
[NVO/1531-2] 22 p0366 N79-21523
- KOBAR, J. A.  
Burn coal cleanly in a fluidized bed - The key is  
in the controls  
22 p0282 A79-26374
- KOBAYASHI, H.  
Phase equilibria in coal hydrogenation systems  
[FE-2334-6] 21 p0171 N79-10238
- KOCH, B.  
Proposal for a representation of the  
quasisteady-state performance of flat-plate  
collectors  
[ASSA-SE-B21/77] 22 p0349 N79-18461



## KOCH, R. C.

Air quality impacts using SRC versus conventional coal in power plants  
[PB-290237/7] 22 p0373 N79-21671

## KOCH, V. R.

The secondary lithium electrode in non-aqueous electrolytes - Some problems, some solutions  
21 p0041 A79-11838

## KOCH, W.

Gasification of raw lignite in the tube-furnace gasifier  
22 p0310 A79-30996

## KOCHEKA, E. L.

Development, testing and evaluation of MHD materials and component designs  
[PB-2248-19] 22 p0369 N79-21558

## KODRAS, F. D.

Environmental assessment for residual oil utilization  
[PB-286982/4] 22 p0336 N79-16446

## KOEHLER, D. E.

Performance characteristics of automotive engines in the United States. First series: Report no. 15 1975 Dodge Colt 98 CID (1.6 liters), 2V  
[PB-286075/7] 21 p0226 N79-15305

Performance characteristics of automotive engines in the United States. Second series: Report no. 5 1977 Ford 140 CID (2.3 liters), 2V  
[PB-286076/5] 21 p0227 N79-15306

Performance characteristics of automotive engines in the United States Third series: Report No. 1 1977 Volvo 130 CID (2.1 liters), F.I.  
[PB-286077/3] 21 p0227 N79-15307

Performance characteristics of automotive engines in the United States. Second series, report no. 4: 1976 Chevrolet 85 CID (1.4 liters), IV  
[PB-286294/4] 21 p0227 N79-15308

Performance characteristics of automotive engines in the United States. Second series, report no. 6: 1976 Nissan diesel 198 CID (3.2 liters), F. I.  
[PB-286295/1] 21 p0227 N79-15309

Performance characteristics of automotive engines in the United States. Second series, report no. 7: 1977 Ford 171 CID (2.8 liters), 2V  
[PB-286296/9] 21 p0227 N79-15310

Performance characteristics of automotive engines in the United States. First series, report no. 16: 1975 121 CID (2.0 liters), F.I.  
[PB-286297/7] 21 p0227 N79-15311

Performance characteristics of automotive engines in the United States. First series, report no. 17: 1975 Buick 455 CID (7.5 liters), 4V  
[PB-286298/5] 21 p0227 N79-15312

Performance characteristics of automotive engines in the United States. First series, report no. 20: 1975 Chevrolet 350 CID (5.7 liters) with dresser variable-area venturi system  
[PB-286301/7] 21 p0228 N79-15315

## KOEHLER, R.

Solar power plants in the U.S.A.  
21 p0057 A79-13640

## KOEHLIG, A.

Vehicle operation on fuels from solar energy  
21 p0059 A79-13663

## KOEHLIG, H. L.

Solid waste and biomass. Their potential as energy sources in Illinois, 1977  
[PB-281649/4] 21 p0177 N79-10562

## KOEHLER, J. K.

Coal slag effects in MHD generators  
21 p0080 A79-14934

## KOEHLER, P. A.

Standards of Practice Manual for the solvent refined coal liquefaction process  
[PB-283028/9] 21 p0178 N79-10595

## KOEHLER, H. K.

Solar electric power supplies - Design and layout  
21 p0057 A79-13639

## KOFESKEY, H. G.

Cold-air performance of free power turbine designed for 112-kilowatt automotive gas-turbine engine. 2: Effects of variable stator-vane-chord setting angle on turbine performance  
[NASA-TN-78993] 22 p0345 N79-17859

## KOIDE, G. T.

Solar and wind energy applications in Hawaii  
21 p0066 A79-14265

## KOIKE, K.

On the flow of a conducting fluid between parallel disks with a transverse magnetic field. I - A theoretical investigation on a nonequilibrium plasma flow as a compressible inviscid fluid  
21 p0156 A79-19445

## KOIZUMI, H.

Solar heating performance of the Toshiba Solar House No. 1  
21 p0137 A79-17465

## KOK, B.

Biological solar energy conversion approaches to overcome yield stability and product limitations  
[PB-284823/2] 21 p0199 N79-12577  
Biological solar energy conversion: Approaches to overcome yield, stability and product limitations  
[PB-286487/4] 21 p0230 N79-15422

## KOLESAR, P. T.

A comparison of the silica and Na-K-Ca geothermometers for thermal springs in Utah  
21 p0097 A79-16075

## KOLIWAD, K. H.

Effect of grain boundaries in silicon on minority-carrier diffusion length and solar-cell efficiency  
22 p0252 A79-21807

## KOLTUN, H. H.

Optimization of electrical and optical characteristics of silicon photocells used for photothermal concentrated solar radiation converters  
21 p0053 A79-13288

New models of solar cells and prospects for their optimization  
21 p0166 A79-20346

Solar-to-thermal energy converter based on coaxial evacuated tubular elements with multilayer and selective coatings  
21 p0167 A79-20356

## KONAGAI, H.

Series resistance effects in /GaAl/As/GaAs concentrator solar cells  
22 p0273 A79-25745

## KONDO, W.

The thermochemical decomposition of water using bromine and iodine  
22 p0238 A79-20770

## KONDRATEV, K. IA.

Radiation regime of inclined surfaces  
22 p0282 A79-26353

## KONDRATYEV, K. Y.

Radiation regime of inclined surfaces  
[WMO-467] 21 p0192 N79-11613

## KONEEV, S. H.-A.

Optimization of a diagonal MHD channel  
22 p0247 A79-21628

## KONOPKA, A.

Alternative forms of energy transmission from OTEC plants  
21 p0141 A79-17505

Feasibility study of transporting offshore OTEC-produced energy to shore by thermal media. Project 8980  
[DSE/2426-19] 21 p0174 N79-10535

## KOOL, K. L.

Energy efficiency in the transport sector  
21 p0054 A79-13574

## KOOHANOFF, F. A.

Status of the SPS concept development and evaluation program  
22 p0326 A79-31919

## KOPAC, Z.

Measurement of radiation intensity by means of a pyrliometer  
21 p0055 A79-13623

## KOPPELMAN, E.

The Koppelman process  
21 p0145 A79-17634  
Upgrading lignite by the Koppelman process  
21 p0146 A79-17641

## KOR, G. J. W.

Desulfurization and sulfidation of coal and coal char  
21 p0045 A79-12120

## KORALEK, C. S.

Standards of Practice Manual for the solvent refined coal liquefaction process  
[PB-283028/9] 21 p0178 N79-10595

PERSONAL AUTHOR INDEX

KRAUSE, B. B.

- Environmental assessment data base for coal  
liquefaction technology. Volume 1: Systems for  
14 liquefaction processes  
[PB-287799/1] 22 p0344 A79-17364
- KORDESCH, K. V.  
Progress in batteries and solar cells. Volume 1  
21 p0148 A79-17989
- KORIAGIN, W. I.  
Production and application of rolling-welded  
aluminum alloy panels for solar water heaters  
for hot water and cooling systems 22 p0297 A79-28670
- KORIAGINA, G. H.  
Technical and economic aspects of open-cycle MHD  
power plants 21 p0105 A79-16482
- KORN, C.  
Electronic structure and physical properties of  
Ti-B and Zr-B using BMR 22 p0248 A79-21685
- KORNBURG, J. P.  
Health maintenance and health surveillance  
considerations for an SPS space construction  
base community  
[AAS PAPER 78-176] 22 p0243 A79-21273
- KORNEGAY, F. C.  
A biologist's manual for the evaluation of impacts  
of coal-fired power plants on fish, wildlife and  
their habitats  
[PB-291330/9] 22 p0373 A79-21679
- KOROLEV, I.  
Use of waste heat from thermal electric power  
plants and nuclear power plants to heat  
greenhouses  
[ORNL-TR-4483] 21 p0221 A79-14574
- KOROLEV, V. H.  
Thermal deformations of solar-energy concentrators  
21 p0166 A79-20355
- KOROVIN, B. V.  
Mass transfer in a current source during  
circulation of the mixture driven by gaseous  
reaction products 21 p0164 A79-19851
- New chemical sources of current 22 p0237 A79-20679
- KORSGAARD, V.  
CCMS solar energy pilot study reporting format -  
The zero energy house in Denmark 22 p0277 A79-25940
- KOS, J. H.  
On-line control of a large horizontal axis wind  
energy conversion system and its performance in  
a turbulent wind environment 21 p0028 A79-10236
- KOSAKA, H.  
A thermal storage analysis on packed bed of  
alumina spheres 21 p0121 A79-17324
- KOSHAL, B. K.  
Energy efficiency in the transport sector  
21 p0054 A79-13574
- KOSSON, B. L.  
Thermal energy storage heat exchanger design  
[ASME PAPER 78-ENAS-30] 21 p0049 A79-12579
- KOSZI, L. A.  
A high-efficiency GaAs double-heterostructure  
photovoltaic detector 21 p0154 A79-18489
- KOTHARI, H. S.  
A new fabrication process for single crystal  
silicon solar cells 21 p0122 A79-17335
- KOTHARI, L. S.  
Response of p-n junction solar cells to  
concentrated sunlight and partial illumination  
21 p0124 A79-17353
- KOTZE, D. J.  
The planning and economic aspects of energy supply  
and demand in South Africa 22 p0341 A79-17325
- KOUBA, G. E.  
A microprocessor based solar monitoring system  
21 p0088 A79-15838
- A microprocessor compatible temperature measuring  
system 21 p0088 A79-15839
- KOUNANS, W. A.  
Electric car project of the Eindhoven University  
of Technology 22 p0302 A79-29498
- KOUTSOUKOS, E. P.  
Coal desulfurization test plant status - July 1977  
21 p0044 A79-12118
- KOVARIK, H.  
Optimal profile of solar energy collectors  
21 p0130 A79-17408
- Optimal distribution of heat conducting material  
in the finned pipe solar energy collector  
22 p0242 A79-21163
- KOVASIUK, V. I.  
MHD generators 21 p0105 A79-16484
- KOWALCZEWSKI, J. J.  
Cost of solar energy 21 p0118 A79-17291
- KOZAWA, A.  
Progress in batteries and solar cells. Volume 1  
21 p0148 A79-17989
- KRAFT, C. C., JR.  
The solar power satellite concept - The past  
decade and the next decade  
[AIAA PAPER 79-0534] 22 p0273 A79-25854
- The Solar Power Satellite concept - Towards the  
future 22 p0327 A79-31925
- KRAFT, E.  
A superconducting dipole magnet for the UTSI MHD  
Facility 22 p0235 A79-20533
- KRAFT, E. P.  
Fabrication experiences and operating  
characteristics of the U.S. SCMS superconducting  
dipole magnet for MHD research 21 p0084 A79-15304
- KRAFT, H.  
Exploitation of solar energy via modular power  
plants and multiple utilization of waste heat  
21 p0141 A79-17497
- KRAFT, H. L.  
Applicability of the Meyers process for  
desulfurization of U.S. coal - A survey of 35  
coals 21 p0044 A79-12117
- KRAGL, W.  
The Trithera test house 22 p0290 A79-27723
- KRAHMER, H. B.  
Observation of voltage fluctuations in a  
Superconducting Magnet during MHD power generation  
22 p0235 A79-20531
- KRALL, H. A.  
Quasi-linear theory of heat flow and diffusion in  
a tokamak 22 p0270 A79-24859
- Theory of the striated corona in a theta pinch  
22 p0295 A79-28315
- KRAMER, P.  
The wind as a potential energy source in future  
hydrogen technology 21 p0059 A79-13661
- KRANIG, J. H.  
Investigation of turbo-dyne energy chamber (G/R:  
value trademark): An air bleed device  
[PB-285381/0] 21 p0217 A79-14397
- KRAFF, R.  
Development of high temperature fuel cell battery  
[BNFT-PB-T-77-17] 22 p0342 A79-17344
- KRAFF, R.  
Investigation of the heat transfer in cylindrical  
receiver configurations with inner tubes  
[ASME PAPER 79-GT-64] 22 p0306 A79-30532
- KRASIOVSKII, V. I.  
Facility with sectioned photoreceiver and laser  
radiator for determining solar radiation  
concentrator accuracy characteristics  
21 p0054 A79-13292
- KRASHOVSKII, A. A.  
Biological conversion of solar energy  
22 p0312 A79-31146
- KRAUSE, B. B.  
Chloride corrosion and its inhibition in refuse  
firing 21 p0080 A79-14930

- Corrosion and deposits from combustion of solid waste. VI - Processed refuse as a supplementary fuel in a stoker-fired boiler [ASME PAPER 78-WA/FU-4] 21 p0160 A79-19788
- KREIDER, J. P.  
Solar energy and the second law of thermodynamics 21 p0118 A79-17292  
Distribution of beam radiation of the receiver plane of a CPC solar concentrator 21 p0135 A79-17451  
Principles of solar engineering 22 p0287 A79-27372  
First-order design variables for concentrating solar collectors 22 p0293 A79-28141
- KREININ, L. B.  
Spectral characteristics of photoconverters with nonuniform defect distribution in the base 21 p0053 A79-13289  
Study of photoelectric characteristics of photocells made from high-resistivity silicon 22 p0296 A79-28666
- KREISCHER, K.  
Characteristics of electron-cyclotron-resonance-heated tokamak power reactors 22 p0292 A79-27885
- KREITH, P.  
Options for solar thermal conversion 21 p0043 A79-11969  
Thermal storage and heat transfer in solar energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978 22 p0280 A79-26201  
Principles of solar engineering 22 p0287 A79-27372
- KREITLOW, D. B.  
Thermosyphon models for downhole heat exchanger applications in shallow geothermal systems 21 p0150 A79-18092
- KREITNER, J. D.  
Northern Alaska hydrocarbon resources [PB-287394/1] 22 p0332 N79-16342
- KREHBIK, S. P.  
Gasification Combined Cycle Test Facility at Pekin, Illinois 21 p0145 A79-17632
- KREUSING, H.  
Gasification of raw lignite in the tube-furnace gasifier 22 p0310 A79-30996
- KRICKENBERGER, K.  
An assessment of mercury emissions from fossil fueled power plants [PB-285227/5] 21 p0213 N79-13592
- KRIEGER, B.  
Analysis of radioactive contaminants in by-products from coal-fired power plant operations [PB-286365/2] 21 p0232 N79-15473
- KRIKORIAN, J. S., JR.  
Development of industrial owned, small hydroelectric facilities 21 p0073 A79-14699
- KRISHBERG, R. R.  
Optimality criteria in the compensation of the longitudinal boundary effect in induction MHD machines 22 p0298 A79-29277  
Limit of formation of counterflows in plane linear induction MHD machines 22 p0298 A79-29288
- KRISHNA, S. A.  
Evaluation and targeting of geothermal energy resources in the southeastern United States [VPI-SU-5648-1] 21 p0204 N79-13478
- KRISHNANATHY, M. V.  
Development of small solar power plants for rural areas in India 21 p0141 A79-17502
- KRISHNAPRASED, K.  
Receiver designs for tower-top solar collector 21 p0135 A79-17450
- KRITCHMAN, B. M.  
Efficient Fresnel lens for solar concentration 22 p0285 A79-26816
- KRIVENTSEV, V. I.  
Evaluation of the effectiveness of electric power systems for transport purposes 22 p0284 A79-26723
- KRIVOSHEEV, E. P.  
Superconductivity in antenna engineering 22 p0311 A79-31008
- KROCHMANN, J.  
Irradiances on inclined surfaces 21 p0055 A79-13624
- KROEGER, R.  
Lithium and potassium heat pipes for thermionic converters 21 p0013 A79-10113
- KROEGER, E. W.  
Diminide thermionic energy conversion with lanthanum-hexaboride electrodes 21 p0053 A79-13098
- KROKHIN, O. N.  
Progress in laser-fusion research 21 p0070 A79-14464
- KRUPINSKI, K. C.  
Fluid-bed carbonization/desulfurization of Illinois coal by the Clean Coke Process - PDU studies 21 p0045 A79-12121
- KRUPNICK, A. C.  
Method for making an aluminum or copper substrate panel for selective absorption of solar energy [NASA-CASE-MPS-23518-1] 21 p0182 N79-11469
- KRUWANT, W. J.  
Economics and net energy analysis - Is a new analytical technique needed for energy decision making 21 p0074 A79-14706
- KRUZHILIN, IU. I.  
Self-adjusting laser-target system for laser fusion 21 p0086 A79-15625
- KUBE, W. R.  
Technology and Use of Lignite [GFERC/IC-77/1] 21 p0216 N79-14241
- KUCHINSKII, G. S.  
Problems in the development of high-service-life capacitative accumulators 22 p0243 A79-21249
- KUCHNEL, R.  
Lead-acid battery: An evaluation of commercialization strategies [NTR-7593] 21 p0220 N79-14565
- KUDIZA, D. A.  
Parametric study of two planar high power flexible solar array concepts [NASA-CR-157841] 21 p0205 N79-13501
- KUEHL, D. J.  
The USA 5MW solar thermal test facility 21 p0135 A79-17449  
Solar thermal test facility experiment manual [SAND-77-1173] 21 p0221 N79-14568
- KUEHN, T. J.  
Accelerating the commercialization on new technologies [ASME PAPER 78-WA/TS-4] 21 p0164 A79-19849
- KUESTER, J. L.  
Liquid fuels from biomass [AIAA PAPER 78-1781] 21 p0063 A79-13876  
Urban wastes as an energy source 21 p0115 A79-17220
- KUHLMAN, P.  
The stirling engine for vehicle propulsion [NASA-TN-75442] 21 p0195 N79-12547
- KUIZENG, D. J.  
Performance of the short-pulse oscillators for Argus and Shiva 21 p0083 A79-15171
- KULASH, D. J.  
Environmental conservation concerns in transportation: Energy, noise, and air quality [PB-286550/9] 21 p0232 N79-15868
- KULCHESKI, G. L.  
Materials problems and possible solutions for near term tokamak fusion reactors 21 p0079 A79-14790  
Energy for the long run - Fission or fusion 22 p0256 A79-22760
- KUHAGAI, T.  
The thermochemical decomposition of water using bromine and iodine 22 p0238 A79-20770

- KUNITOMO, T.**  
Optimum design parameters of horizontal coaxial cylinders for a solar energy collector  
21 p0134 A79-17444
- KUNZ, B. B.**  
The state-of-the-art of hydrogen-air phosphoric acid electrolyte fuel cells  
21 p0039 A79-11815
- KUO, H. C. T.**  
Preliminary environmental assessment of energy conversion processes for agricultural and forest product residues, volume 1  
[PB-281189/1] 21 p0178 A79-10574
- KUO, S. C.**  
Parametric analysis of power conversion systems for central receiver solar power generation  
[ASME PAPER 78-WA/SOL-2] 21 p0162 A79-19835  
Conceptual design of a solar powered closed-cycle gas turbine electric power generation system  
[ASME PAPER 79-GT-43] 22 p0306 A79-30522
- KURLAND, R. M.**  
Design features of the TDRSS solar array  
21 p0002 A79-10019
- KURNOSOV, V. I.**  
Problems in the use of cryogenic pumps in thermonuclear synthesis  
22 p0305 A79-30264
- KURODA, K.**  
Design of a D-shaped toroidal field coil  
21 p0156 A79-19083
- KUROKAWA, K.**  
Proposal for efficient appreciation of solar thermal absorptive materials by high irradiance solar simulator  
21 p0130 A79-17406
- KUROSAKI, Y.**  
Heat transfer in a solar radiation absorbing fluid layer flowing over a substrate  
22 p0281 A79-26204
- KUSHIDA, R.**  
Continuous extrusion of coal  
22 p0282 A79-26372
- KUSIK, C. L.**  
Energy use patterns for metal recycling  
[PB-284855/4] 21 p0201 A79-13152
- KUSTON, R. L.**  
Fabrication experiences and operating characteristics of the U.S. SCMS superconducting dipole magnet for MHD research  
21 p0084 A79-15304
- KUTREV, B. V.**  
Investigation of the Hall effect in a discharge with a rotational electric field  
22 p0246 A79-21532
- KUTYB, H.**  
Modelling and control of a fluidized bed gasifier  
22 p0332 A79-16345
- KUWAHARA, H.**  
The use of heat exchangers with THERMOXYCEL's tubing in ocean thermal energy power plants  
[ASME PAPER 78-WA/HT-65] 21 p0162 A79-19825
- KUZNETSOV, M. V.**  
Effect of the magnetic configuration of the poloidal diverter on the plasma in the T-12 finger-ring tokamak  
22 p0244 A79-21429
- KUZNETSOV, V. I.**  
Optimization of a Knudsen Cs-Ba thermionic converter  
22 p0241 A79-20940
- KUZNETSOV, I. V.**  
Some heat transfer and hydrodynamic problems associated with superconducting cables (SPTL)  
[NASA-TN-79023] 21 p0226 A79-15267
- KVARTSKHAVA, I. P.**  
Plasma behavior near the neutral line between parallel currents  
22 p0324 A79-31754
- KYDD, P. B.**  
H-coal products for direct application to power generation  
21 p0006 A79-10056
- KYLE, B.**  
Passive solar heating - Results from two Saskatchewan residences  
22 p0322 A79-31444
- LA STELLA, J. P.**  
Role and status of dispersed electric utility fuel cell power plants  
21 p0093 A79-15894
- LABELLE, D.**  
Statistical analysis of solar radiation data in Montreal for solar energy utilization  
22 p0322 A79-31452
- LABOVITE, C.**  
Stabilization of power plant scrubbing slurries and fine coal refuse with the additive Calcilox  
21 p0063 A79-14107
- LACEY, D. R.**  
Dynamic response of a wind turbine system and its effect on performance  
21 p0067 A79-14293
- LADESIC, B. P.**  
Ambient air quality assessment of the Synthane coal gasification pilot plant, six month study /August 1976-January 1977/  
21 p0064 A79-14113
- LADSAONGIKAR, U. V.**  
Design and optimization of a flat plate collector for cooling application  
21 p0132 A79-17419
- LAFRANBOISE, P.**  
Statistical analysis of solar radiation data in Montreal for solar energy utilization  
22 p0322 A79-31452
- LAGOWSKI, J.**  
Present status of GaAs  
[NASA-CR-3093] 21 p0215 A79-14192
- LAHR, B. B.**  
Pilot's view of the evolving air transport  
21 p0053 A79-13085
- LAIRD, A. D. K.**  
Geothermal power and water production studies at the University of California  
[ASME PAPER 78-WA/ENER-7] 21 p0159 A79-19778
- LAL, A.**  
Design and performance of 1/4 H.P. solar power unit  
21 p0141 A79-17503
- LAMEIRO, G. F.**  
Options for solar thermal conversion  
21 p0043 A79-11969  
A Markov model of solar energy systems  
21 p0138 A79-17476  
A Markov model of solar energy space and hot water heating systems  
22 p0295 A79-28353
- LAMETHE, D.**  
Investigation of the optimal use of geothermal waters for the heating of several types of dwelling in various European climates  
21 p0075 A79-14739
- LANICH, G. J.**  
HYCSOS - A system for evaluation of hydrides as chemical heat pumps  
22 p0252 A79-21716
- LANOBEAUX, B. D.**  
New instrumentation for high temperature and hemispherical measurements of selective surfaces  
22 p0294 A79-28152
- LANORTE, M. P.**  
A two-junction cascade solar-cell structure  
22 p0256 A79-22856
- LAMPERT, C. B.**  
Microstructural characterization of a black chrome solar selective absorber  
22 p0294 A79-28151
- LANSON, K. C.**  
A methodology for assessing the potential impact on air quality resulting from geothermal resource development in the Imperial Valley  
21 p0116 A79-17262
- LANAUZE, B. D.**  
Investigation of the corrosion performance of boiler, air heater, and gas turbine alloys in fluidized combustion systems  
21 p0080 A79-14931
- LANDER, B. B.**  
Shale oil - The answer to the jet fuel availability question  
[SAE PAPER 781027] 22 p0274 A79-25900

LANDGREBE, A. R.

PERSONAL AUTHOR INDEX

LANDGREBE, A. R.  
Batteries for transportation and load-leveling applications 21 p0041 A79-11837

LANDSBERG, P. T.  
Thermodynamics of the conversion of diluted radiation 22 p0310 A79-30910

LANG, D. E.  
Flying angle of attack 21 p0048 A79-12384

LANG, E.  
A methodology for assessing the potential impact on air quality resulting from geothermal resource development in the Imperial Valley 21 p0116 A79-17262

LANGENKAMP, E.  
Problems around Fe-Cl cycles 22 p0238 A79-20771

LANGER, H.  
Development of multi-density silicon nitride turbine rotors 21 p0050 A79-12832

LANGSJOEN, P. L.  
Low-sulfur western coal use in existing small and intermediate size boilers [PB-287937/7] 22 p0346 W79-18061

LANGSTON, W.  
Design of superconducting magnets for full-scale MHD generators 21 p0084 A79-15306

LAWLER, J. H.  
Controlling NOx from a coal-fired MHD process 21 p0017 A79-10139

LAWNING, D. D.  
Stored energy calculation: The state of the art [PNL-2581] 21 p0210 W79-13541

LAWNING, P. L.  
The updated algorithm of the Energy Consumption Program (ECP): A computer model simulating heating and cooling energy loads in buildings 22 p0351 W79-19059  
A two-dimensional thermal analysis of a new high-performance tubular solar collector 22 p0352 W79-19060

LAWYER, H.  
High reliability contacts for miniature thermoelectric converters 21 p0027 A79-10228  
Solar furnace type high power density thermoelectric generator 21 p0027 A79-10229

LAWYER, P. W.  
Energy-related pollutants in the environment: The use of short-term for mutagenicity in the isolation and identification of biohazards [CONF-780121-2] 21 p0192 W79-11568

LARIONOV, H. H.  
Laser measurements of the radial profiles of the electron temperature and density in the FT-1 tokamak 22 p0244 A79-21430

LA ROCK, R. I.  
Satellite power systems /SPS/ overview 21 p0002 A79-10022  
Satellite power systems program 21 p0169 W79-10128

LARSON, D. C.  
Double-exposure collector system for solar heating applications 21 p0131 A79-17411

LARSSON, L.  
Large-scale introduction of wind power stations in the Swedish grid A simulation study 22 p0300 A79-29373

LAU, C. V.  
MHD conversion of solar energy 21 p0109 A79-16614

LAU, C.-V.  
A high temperature Rankine binary cycle for ground and space solar engine applications 21 p0108 A79-16613

LAULAINEN, H. S.  
Differential insolation and turbidity measurements 22 p0241 A79-21056

LAURENT, G.  
Investigation of the optimal use of geothermal waters for the heating of several types of dwelling in various European climates 21 p0075 A79-14739

LAVE, C. A.  
Environmental conservation concerns in transportation: Energy, noise, and air quality [PB-286550/9] 21 p0232 W79-15868

LAW, S. L.  
Antimony, arsenic, and mercury in the combustible fraction of municipal solid waste [PB-285196/2] 21 p0213 W79-13590

LAWARD, T. A.  
New approaches for the appropriate use of solar energy in northern climates 22 p0319 A79-31424

LAWRENCE, L. R., JR.  
ERDA fuel cell programs 21 p0039 A79-11814

LAWSON, D. D.  
Dual membrane hollow fiber fuel cell and method of operating same [NASA-CASE-WFO-13732-1] 21 p0172 W79-10513

LAWSON, L. J.  
Application of kinetic energy storage to transportation systems 22 p0299 A79-29337  
Study of flywheel energy storage Volume 1: Executive summary [PB-282652/7] 21 p0176 W79-10555  
Study of flywheel energy storage. Volume 2: Systems analysis [PB-282653/5] 21 p0176 W79-10556  
Study of flywheel energy storage. Volume 3: System mechanization [PB-282654/3] 21 p0177 W79-10557  
Study of flywheel energy storage. Volume 4: Life-cycle costs [PB-282655/0] 21 p0177 W79-10558  
Study of flywheel energy storage. Volume 5: Vehicle tests [PB-282656/8] 21 p0177 W79-10559  
Wayside energy storage summary. Volume 1: Summary [DOT-TSC-FRA-79-7-1-VOL-1] 22 p0370 W79-21563

LAYS, E.  
Turbine engines in light aircraft 21 p0047 A79-12380

LAZARENKO, I. S.  
Ways of improving steam-gas power plants 22 p0299 A79-29298

LAZARETH, O.  
Hydrogen production from high temperature electrolysis and fusion reactor 21 p0015 A79-10126

LAZZARI, M.  
Silver selenate and silver tellurate as positive materials for lithium primary power sources 22 p0245 A79-21484

LAZZARIN, R.  
Performance predictions of a LiBr absorption air conditioner utilizing solar energy 21 p0139 A79-17482

LE DET, M.  
Experiments in solar space heating and cooling for moderately insulated regions 21 p0137 A79-17464

LE GRIVES, E.  
A cavity receiver design for solar heated gas turbine generating systems [ONERA, TP NO. 1978-137] 21 p0155 A79-18560

LE, H. T.  
WATSON - A simulation program for solar-assisted heating systems 22 p0321 A79-31439

LE, T.  
Assessment of the solid waste impact of the National Energy Plan [BNL-50708] 21 p0213 W79-13572

LEACH, S.  
Novel duplex vapor electrochemical method for silicon solar cells [NASA-CR-158039] 21 p0218 W79-14537

LEARY, P.  
Predicted performance of heliostats for ERDA's 10 MWe power plant 21 p0044 A79-12045

PERSONAL AUTHOR INDEX

LEUNG, K.

- LEAVENS, J. M.  
Engineering and economic analysis of waste to energy systems [PB-285797/7] 21 p0224 A79-14946
- LEEDEEV, A. D.  
Laser measurements of the radial profiles of the electron temperature and density in the FT-1 tokamak 22 p0244 A79-21430
- LECART, B.  
A new thermochemical process for hydrogen production 22 p0312 A79-31153
- LECHEVIN, L.  
Underground gasification of coal at deep levels - Perspectives and problems 21 p0156 A79-19401
- LECHTHALER, C. H.  
Novel technology for conversion of methanol and synthesis gas to hydrocarbons 21 p0007 A79-10064
- LEE, C. H.  
Measurements of compressed core density of laser-imploded targets by x-ray continuum-edge shift 21 p0154 A79-18479
- LEE, G.  
Status and summary of laser energy conversion 21 p0111 A79-16635
- LEE, G. K.  
Modification of electrostatic precipitator performance by use of fly-ash conditioning agents [ASME PAPER 78-WA/APC-3] 21 p0158 A79-19736
- LEE, H.  
An optimal standard for solar heating systems [ASME PAPER 78-WA/DSC-19] 21 p0159 A79-19765
- LEE, H. Y.  
Radiant exchange for a fin and tube solar collector 22 p0271 A79-25066
- LEE, J. H.  
Investigation of a staged plasma-focus apparatus 22 p0255 A79-22365
- LEE, J. W.  
Combustion modification pollutant control techniques for industrial boilers - The influence of fuel oil properties and atomization parameters [ASME PAPER 78-WA/APC-13] 21 p0159 A79-19742
- LEE, K. P.  
Influence of cyclic wall-to-gas heat transfer in the cylinder of the valved hot-gas engine 21 p0024 A79-10201
- LEE, P.  
Two-dimensional monochromatic X-ray imaging of laser-produced plasmas 22 p0296 A79-28366
- LEE, S. C.  
A systems study of our energy problems 21 p0074 A79-14704
- LEE, T. G.  
Integration of a passive and active solar heated, low density, multiple dwelling with atrium 22 p0322 A79-31446
- LEES, D. J.  
Heating and confinement in the CLEO stellarator 21 p0070 A79-14459
- LEFEBVRE, A. H.  
Ignition/stabilization/atomization - Alternative fuels in gas turbine combustors 21 p0052 A79-12982
- LEFEBVRE, Y.  
Solar heating of domestic hot water at the Confederation Heights Cafeteria 22 p0323 A79-31457
- LEFKOWITZ, I.  
Modelling energy storage systems for electric utility applications Preliminary considerations 21 p0081 A79-14960
- LEFLAR, J. A.  
Simulation and design of evacuated tubular solar residential air conditioning systems and comparison with actual performance 21 p0138 A79-17475
- Solar evacuated tube collector: Absorption chiller systems simulation [COO-2577-13] 21 p0209 A79-13530
- LEFROIS, R. T.  
Active heat exchange system development for latent heat thermal energy storage [NASA-CR-159479] 22 p0368 A79-21554
- LEHRFELD, D.  
Development of a 1 kW/e/ isotope fueled Stirling cycle power system 21 p0025 A79-10210
- The Stirling engine, an energy converter for cogeneration applications [ASME PAPER 78-WA/ENER-4] 21 p0159 A79-19777
- LEICHTER, I.  
Air quality impacts using SRC versus conventional coal in power plants [PB-290237/7] 22 p0373 A79-21671
- LEIGH, D. C.  
Computer aided optimization of integrated coal gasification combined cycle power plants 21 p0008 A79-10075
- LEIGH, J. G.  
Projecting energy resource utilization - The geothermal case 21 p0068 A79-14321
- LEIGH, R. W.  
A method for the comparative economic assessment of storage systems 21 p0013 A79-10111
- LEIPOLD, H. H.  
Recent developments in low cost silicon solar cells for terrestrial applications 22 p0239 A79-20821
- LEISING, C. J.  
Utilization of waste heat in trucks for increased fuel economy [NASA-TN-79966] 21 p0215 A79-13937
- LELOUP, C.  
Conceptual design of a superconducting tokamak - 'TORUS II SUPRA' 22 p0236 A79-20543
- LEMASOV, B. I.  
Experimental investigation of the joint operation of wind and solar plants 21 p0167 A79-20358
- LENDER, R. J.  
Diffusion length measurements in Schottky barrier GaAs solar cells 22 p0281 A79-26243
- LENNHARD, J.  
New approaches for the appropriate use of solar energy in northern climates 22 p0319 A79-31424
- LEONARD, J. A.  
Operating experience at the DOE/Sandia midtemperature Solar Systems Test Facility 21 p0022 A79-10182
- LEONARD, J. V.  
Current state-of-the-art of electrochemical batteries from a users point of view 21 p0071 A79-14681
- LEOPOLD, L.  
Environmental considerations for the microwave beam from a solar power satellite 21 p0003 A79-10030
- Design considerations for solar power satellites 21 p0113 A79-16738
- LERFELD, G. H.  
Effects of weather and pollution on incident solar energy - Basic measurements leading to computer models 21 p0065 A79-14117
- LESCHLY, K.  
User experience with on-road electric vehicles in the U.S.A. and Canada 21 p0009 A79-10080
- LESHENDOK, T. V.  
Remote sensing and mine subsidence in Pennsylvania 22 p0303 A79-29936
- LESHUK, J. P.  
Solar pond stability experiments 21 p0042 A79-11878
- LESPEANCE, H. J.  
Control system for solar hot water system 22 p0321 A79-31442
- LESTIENNE, R.  
Storage tank efficiency as simulated in a Markovian model of meteorology 22 p0254 A79-22272
- LEUNG, K.  
A computerized reporting and monitoring system for geothermal energy development [LBL-8483] 22 p0369 A79-21555

- LEUNG, K. B.  
Magnetic multipole line-cusp plasma generator for  
neutral beam injectors 22 p0238 A79-20746
- LEVART, H.  
A study of positive electrode materials for  
batteries operating in a halide-aluminate medium 22 p0245 A79-21480
- LEVELTON, B. H.  
An evaluation of wood-waste energy conversion  
systems 21 p0174 N79-10528
- LEVERENZ, D. J.  
Design of solar heating and cooling systems  
[AD-A062719] 22 p0363 N79-20522
- LEVESQUE, D.  
Theoretical and experimental analysis of a latent  
heat storage system 21 p0121 A79-17323
- LEVI, E.  
Inverter systems 21 p0106 A79-16486
- LEVIN, A.  
Attenuating the transverse edge effect in MHD  
generators 21 p0063 A79-13985
- LEVIN, L. S.  
Laser measurements of the radial profiles of the  
electron temperature and density in the FT-1  
tokamak 22 p0244 A79-21430
- LEVIN, V. H.  
Combustion of hydrogen in a supersonic flow in a  
channel in the presence of a pseudodiscontinuity 22 p0324 A79-31845
- LEVTEHOV, A. I.  
Investigation of the thermophysical  
characteristics of cryogenic heat pipes with a  
metal-fiber wick 22 p0288 A79-27529
- LEVY, J. H.  
Combustion research on the fate of fuel-nitrogen  
under conditions of pulverized coal combustion  
[PB-286208/4] 21 p0232 N79-15474
- LEVY, R. B.  
Catalysis in coal conversion 21 p0051 A79-12873
- LEWELLEN, W. S.  
Modeling two-phase flow in a swirl combustor 22 p0280 A79-26189
- LEWIS, A.  
Future aviation fuels fuel suppliers views 21 p0202 N79-13194
- LEWIS, B. G.  
A biologist's manual for the evaluation of impacts  
of coal-fired power plants on fish, wildlife and  
their habitats [PB-291330/9] 22 p0373 N79-21679
- LEWIS, F. A.  
Hydrogen storage electrode systems 22 p0251 A79-21710
- LEWOLT, J. G.  
Fuel conservative subsonic transport 22 p0337 N79-16874
- LEY, W.  
Solar radiation simulation by means of solar  
simulator for the indoor testing of solar  
collectors 21 p0055 A79-13620
- LEYERLY, R. W.  
Optimization of PtDoped KOCITE (trade name)  
electrodes in H<sub>3</sub>PO<sub>4</sub> fuel cells  
[AD-A061242] 22 p0342 N79-17340
- LI, C. T.  
Chemical production from waste carbon monoxide:  
its potential for energy conservation  
[BNWL-2137] 21 p0170 N79-10179
- LI, K. Y.  
Process feasibility study in support of silicon  
material task 1 [NASA-CR-158034] 21 p0219 N79-14541
- LIA, Y.  
The Stirling engine for automotive application  
[SAE PAPER 790329] 22 p0315 A79-31370
- LIBBY, D. O.  
Power cables to accommodate the motions of an OTEC  
plant 21 p0101 A79-16251
- LIBERATORE, A. J.  
Design considerations for an in situ gasification  
test of eastern bituminous coals 21 p0005 A79-10049
- LIRQWITZ, G. G.  
The prospects of hydrogen as an energy carrier for  
the future 22 p0247 A79-21677
- LICHTBLAU, J. H.  
Outlook for world oil into the 21st century with  
emphasis on the period to 1990 [EPRI-PA-745] 21 p0181 N79-11454
- LICHTENBERG, A. J.  
Minimum-average-B wells in linked magnetic mirror  
fields 22 p0252 A79-22237
- LIDORENKO, W. S.  
New models of solar cells and prospects for their  
optimization 21 p0166 A79-20346
- LIEBERMAN, M. A.  
Minimum-average-B wells in linked magnetic mirror  
fields 22 p0252 A79-22237
- LIEBERT, C. H.  
Tests of NASA ceramic thermal barrier coating for  
gas-turbine engines [NASA-TN-79116] 22 p0357 N79-20118
- LIEBLEIN, S.  
Evaluation of urethane for feasibility of use in  
wind turbine blade design [NASA-CR-159530] 22 p0360 N79-20497
- LIEBERT, K.  
Economic prospects for the application of new  
electric energy storage devices 22 p0246 A79-21490
- Solar water heating [BNFT-PB-T-77-42] 22 p0349 N79-18457
- LIEH, P. L.  
Energy and Technology Review, June 1978  
[UCRL-52000-78-6] 21 p0215 N79-14168
- LIEPINS, G. E.  
Buildings energy use data book, edition 1  
[ORNL-5363] 22 p0348 N79-18447
- LIGHTHILL, J.  
Two-dimensional analyses related to wave-energy  
extraction by submerged resonant ducts 22 p0312 A79-31099
- LIKALA, R. C.  
Perspective on the fusion-fission energy concept 21 p0095 A79-15913
- LIKHACHEV, A. P.  
Supersonic flow in an MHD channel with a downwash  
flow at the inlet 21 p0085 A79-15342
- LILLEHNT, L. U.  
Annual collection and storage of solar energy for  
the heating of buildings 21 p0131 A79-17415
- Earth-conducted heat losses from thermal storage  
systems 22 p0281 A79-26208
- LIN, C.  
An economic analysis of synthetic fuels production  
from eastern oil shale via hydrotretort processing 22 p0264 A79-23780
- LIN, C. J.  
Desulfurization of coals by high-intensity  
high-gradient magnetic separation - Conceptual  
process design and cost estimation 21 p0044 A79-12116
- LIN, C. L.  
High-efficiency thin-film polycrystalline-silicon  
solar cells 22 p0273 A79-25744
- LIND, H. A.  
Specularity measurements for solar materials 22 p0294 A79-28153
- LINDAHL, B. C.  
The application of indirectly fired open cycle gas  
turbine systems utilizing atmospheric pressure  
fluidized bed combustors to industrial  
cogeneration situations [ASME PAPER 79-GT-16] 22 p0306 A79-30510
- LINDHOLM, P. A.  
Application of the superposition principle to  
solar-cell analysis 22 p0300 A79-29426

- LINDHAYER, J.  
Vertical junction silicon solar cell  
21 p0001 A79-10013
- LINDROSE, A. H.  
The thermomechanical behavior of polyvinyl butyral  
film and its effect on focal stability of a  
solar mirror-laminate  
22 p0239 A79-20824
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- LINFORD, R. B. F.  
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system  
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An operating 200 kW horizontal axis wind turbine  
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the evaluation of a solar domestic hot water  
system  
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oils  
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- LITTAUER, E. L.  
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- LOFTING, B.  
The economics of geothermal energy development at  
the regional level  
22 p0256 A79-22756



- LOHMAN, R. P.  
Analytical evaluation of the impact of broad specification fuels on high bypass turbofan engine combustors  
[NASA-CR-159454] 21 p0200 N79-13050
- LOKAI, W. V.  
Study of a heat exchanger with heat pipes within the system of a small-scale gas-turbine engine 21 p0114 A79-16800
- LOKHANSEKIN, M.  
Energy utilization analysis of buildings 21 p0103 A79-16462  
Solar energy research, development and demonstration program in Kuwait 21 p0117 A79-17282  
Analysis and design of solar buildings using the Cal-ERDA computer programs 21 p0137 A79-17463
- LONG, B. H.  
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[NASA-TP-1359] 21 p0223 N79-14679
- LONGLEY, W. L.  
Managing oil and gas activities in coastal environments  
[PB-283677/3] 21 p0199 N79-12576
- LONGWELL, J. P.  
Alternative aircraft fuels 21 p0033 A79-10824  
Alternative fuels and combustion problems 21 p0051 A79-12978
- LOPER, D. E.  
On the diffusive instability of some simple steady magnetohydrodynamic flows 22 p0278 A79-26163
- LOPEZ, M.  
Automated array assembly, phase 2. Low-cost solar array project, task 4  
[NASA-CR-158365] 22 p0358 N79-20481
- LOPEZ, S.  
Total solar radiation in Mexico using sunshine hours and meteorological data 21 p0150 A79-18026
- LORENZO, E.  
The effect of the dispersion of the characteristics of solar cells in large systems 22 p0285 A79-26822
- LORRINAN, D.  
Report on a survey of operational solar systems 22 p0318 A79-31418  
Performance of the Meadowvale solar home 22 p0318 A79-31420  
Off-peak electrical backup experience in the Meadowvale Solar Experiment 22 p0318 A79-31421
- LORSCH, B. G.  
Residential and commercial thermal storage 21 p0090 A79-15865
- LOTH, J. L.  
Hybrid air to water solar collector design 21 p0021 A79-10174
- LOTT, D. R.  
Concentrator enhanced solar arrays design study  
[NASA-CR-158032] 21 p0219 N79-14546
- LOTTIN, J. C.  
Conceptual design of a superconducting tokamak - 'TORUS II SUPRA' 22 p0236 A79-20543
- LOUBSKY, W. J.  
The MHD interaction and plasma properties in a shock tube driven disk generator with swirl 21 p0083 A79-15260
- LOUGHEED, V. R.  
Melting multifoil insulation for KIPS emergency cooling 21 p0023 A79-10191
- LOUIS, J. P.  
The MHD interaction and plasma properties in a shock tube driven disk generator with swirl 21 p0083 A79-15260  
MHD generators 21 p0105 A79-16484  
Critical contributions in MHD power generation  
[FE-2215-11] 22 p0362 N79-20511
- LOUNSBURY, B.  
Resource analysis: Water and energy as linked resources  
[PB-288046/6] 22 p0349 N79-18463
- LOUTFY, R. O.  
Photovoltaic properties of metal-free phthalocyanines - A1/H2Pc Schottky barrier solar cells 22 p0317 A79-31412
- LOVEJAY, S. B.  
Local perceptions of energy development: The case of the Kaiparowits Plateau  
[PB-287314/9] 22 p0335 N79-16380
- LOWENSTEIN, A. I.  
Shock tube studies of coal devolatilization 21 p0083 A79-15247
- LOWRY, W.  
A test bed for thermosyphon solar air collectors  
[AIAA PAPER 79-0541] 22 p0274 A79-25860
- LOWTHER, J. D.  
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[AD-A059993] 21 p0217 N79-14507
- LU, P. W. T.  
Electrochemical-ellipsometric studies of oxide films formed on nickel during oxygen evolution 21 p0038 A79-11799
- LUBIS, W.  
Flux-redistribution in the focal region of a planar Fresnel ring mirror 22 p0263 A79-23764
- LUCAS, J.  
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- LUCAS, J. W.  
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[AIAA PAPER 78-1771] 21 p0062 A79-13869
- LUCAS, W. J.  
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[AD-A058200] 21 p0197 N79-12563
- LUDWIG, L. P.  
Energy conservation through sealing technology 22 p0237 A79-20700
- LUFT, W.  
Design features of the TDRSS solar array 21 p0002 A79-10019
- LUKENS, L. L.  
Solar powered irrigation: Present status and future outlook  
[SAND-78-0016C] 21 p0175 N79-10539  
Solar irrigation program plan: Second revision  
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[SAND-77-1403] 21 p0220 N79-14566
- LUND, W. W., JR.  
A microwave power transmission system for space satellite power 21 p0002 A79-10025  
Microwave phased array design considerations for SPS 21 p0003 A79-10031
- LUNDBERG, R. B.  
Hydrogen - Potential key to tomorrow's energy utility 22 p0289 A79-27657
- LUNDE, P. J.  
Prediction of the performance of solar heating systems utilizing annual storage 22 p0263 A79-23760
- LUNDIN, C. E.  
A new rationale for the hysteresis effects observed in metal-hydrogen systems 22 p0250 A79-21704
- LUONGO, G.  
Shallow magmatic reservoirs as heat source of geothermal systems - Preliminary interpretation of data available for the Neapolitan active volcanic areas 21 p0075 A79-14727
- LUQUE, A.  
Transcell, a novel approach for improving static photovoltaic concentration 21 p0124 A79-17356  
The effect of the dispersion of the characteristics of solar cells in large systems 22 p0285 A79-26822

- LOSTENADDER, E. L.**  
Laboratory evaluation of a composite flywheel energy storage system 21 p0013 A79-10110  
A status of the 'Alpha-ply' composite flywheel concept development 22 p0241 A79-20843
- LUTON, J. W.**  
The role of the Large Coil Program in the development of superconducting magnets for fusion reactors 22 p0236 A79-20541
- LOTWACK, R.**  
Electricity from sunlight 21 p0065 A79-14116
- LUTZ, S. J.**  
Evaluation of dry sorbents and fabric filtration for PGD (Flue Gas Desulfurization) [PB-289921/9] 22 p0373 A79-21661
- LUXENBERG, B. A.**  
United States civilian space programs: An overview [GPO-35-823] 21 p0232 A79-15815
- LYKOV, V. A.**  
Hybrid reactor based on laser-induced thermonuclear fusion 21 p0032 A79-10658
- LYMAN, W. S.**  
Optimum collection geometries for copper tube - copper sheet flat plate collectors 21 p0127 A79-17387
- LYNCH, F. R.**  
A new rationale for the hysteresis effects observed in metal-hydrogen systems 22 p0250 A79-21704
- LYNN, S.**  
A new power cycle that combines power generation with energy storage 21 p0004 A79-10040
- LYSAKOVSKII, G. G.**  
Problems in the development of high-service-life capacitive accumulators 22 p0243 A79-21249
- LYSENKO, S. E.**  
Recombination-induced neutral-particle flux in tokamaks 22 p0291 A79-27877
- LYTLE, J. K.**  
The MHD interaction and plasma properties in a shock tube driven disk generator with swirl 21 p0083 A79-15260
- M**
- MAAG, W. L.**  
Comparison of fuel-cell and diesel integrated energy systems and a conventional system for a 500-unit apartment [NASA-TN-79037] 21 p0229 A79-15403
- MAASS, K.**  
Development of a 1 kW fuel cell aggregate with acid electrolyte 21 p0148 A79-17994
- MADES, D. L.**  
A biologist's manual for the evaluation of impacts of coal-fired power plants on fish, wildlife and their habitats [PB-291330/9] 22 p0373 A79-21679
- MACCIEL, E.**  
A comparison between sun and wind as energy sources in irrigation plants 21 p0118 A79-17295  
Power cycles and working fluids for low temperature heat sources 22 p0332 A79-16268
- MACPARRLANE, J. J.**  
Future fuels for aviation 21 p0201 A79-13193  
The role of fundamental combustion in the future aviation fuels program 21 p0202 A79-13195
- MACGREGOR, A. W. K.**  
Economic use of materials in the design of solar water-heating collector plates of the pipe and fin type 21 p0129 A79-17396
- MACHIDA, Y.**  
Hydride formation of C14-type Ti alloy 22 p0250 A79-21701
- MACHUEV, IU. I.**  
Thermal deformations of solar-energy concentrators 21 p0166 A79-20355
- MACKINTOSH, B.**  
Large area silicon sheet by EPG 21 p0123 A79-17340
- MACLEOD, E. M.**  
Evaluation and optimization of Solid Polymer Electrolyte (SPE) fuel cells [AD-A058380] 21 p0206 A79-13505
- MACHILLAN, W. L.**  
Testing to assess the affect of degraded fuel specifications on the cold start ability of a T63-A-700 engine [AIAA 79-7009] 22 p0300 A79-29384
- MADAN, A.**  
A new amorphous silicon-based alloy for electronic applications 21 p0100 A79-16226
- MADAN, B. K.**  
Response of a solar cell to intense and nonuniform illumination when used with solar concentrators 21 p0125 A79-17357
- MAEDA, H.**  
General view of low cost solar cell development in Japan 21 p0149 A79-17997
- MAEDA, K.**  
MHD gas turbine energy conversion for mirror fusion reactors 22 p0313 A79-31192
- MAEKAWA, T.**  
Electron cyclotron heating in high density toroidal plasmas 22 p0265 A79-24037
- MAELAND, A. J.**  
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Survey of the different types of hydrides 22 p0247 A79-21678
- MAGAL, B. S.**  
Mechanical energy storage system for a 10 KWe solar power pack 21 p0121 A79-17329
- MAGDELEBAT, J.-L.**  
Solar energy via satellites and international cooperation 22 p0310 A79-30952
- MAGEE, E. A.**  
Trace element emissions from coal-fired power plants [ASME PAPER 78-WA/PU-9] 21 p0160 A79-19789  
Sampling and analysis of synthetic fuel processes 22 p0284 A79-26538
- MAGLISSEN, G. R.**  
Pellet X-ray spectra for laser fusion reactor designs 22 p0291 A79-27878
- MAGGITT, L.**  
Future fuels in gas turbine engines 21 p0051 A79-12979
- MAGNOLI, D.**  
Thermosyphon solar water heating system under Brazilian conditions 21 p0021 A79-10177
- MAHAJAN, S. N.**  
Stability criteria for current-driven drift wave eigenmodes 22 p0269 A79-24813
- MAHEPKKEY, E. T.**  
Military needs for orbital power 21 p0169 A79-10127
- MAHONEY, J. R.**  
Energy consumption of environmental controls - Fossil fuel, steam electric generating industry 21 p0064 A79-14112
- MAIDANIK, IU. P.**  
Design of a heat pipe with separate channels for vapor and liquid 22 p0268 A79-24486
- MAITRA, K.**  
Investigation on junction formation and realisation of high open-circuit voltage in Cu/x/S-CdS solar cells 21 p0123 A79-17344
- HAJEB, E. L.**  
Seismological investigations in geothermal regions 22 p0356 A79-19506

- MAKABE, H.**  
Reaction mechanism of alkali-alcohol treatment of coal  
22 p0299 A79-29315
- MAKAEV, I. V.**  
Effect of the properties of the working body on the selection of the temperature of the surface of the electrodes of the channel of an MHD generator  
21 p0167 A79-20419
- MAKHLIN, A. G.**  
Stability of work and sensitivity of semiconductor thermoelectric systems under automatic control  
22 p0261 A79-23624
- MAKOWITZ, R.**  
The fast power cycle for fusion reactors  
21 p0018 A79-10152
- MAKSIMENKO, V. I.**  
U-25B MHD unit for carrying out investigations under the conditions of strong electric and magnetic fields  
21 p0049 A79-12692  
Channel No. 1 of the MHD generator of a U-25B unit for carrying out investigations in strong electric and magnetic fields  
21 p0049 A79-12693
- MAKSIMOV, G. H.**  
Mass transfer in a current source during circulation of the mixture driven by gaseous reaction products  
21 p0164 A79-19851
- MAKSIMOV, V. I.**  
Electric power losses of current input into superconducting devices cooled by supercritical helium  
22 p0235 A79-20530
- MAJCOLN, J. W.**  
Use of solar energy to heat anaerobic digesters. Part 1: Technical and economic feasibility study. Part 2: Economic feasibility throughout the United States  
[PB-286940/2]  
21 p0231 A79-15440
- MALECHA, R. P.**  
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21 p0010 A79-10086
- MALEK, A.**  
Current problems in the development and production of small gas turbine engines  
21 p0048 A79-12529
- MALES, R. H.**  
Exploring future energy options - An economic analysis  
21 p0068 A79-14324
- MALEVSKII, I. U. M.**  
Production and application of rolling-welded aluminum alloy panels for solar water heaters for hot water and cooling systems  
22 p0297 A79-28670
- MALIK, H. A. S.**  
Solar energy research, development and demonstration program in Kuwait  
21 p0117 A79-17282
- MALIK, H. J.**  
Emissions and economy potential of prechamber stratified charge engines  
[SAE PAPER 790436]  
22 p0315 A79-31374
- MALIK, S. K.**  
Structure and bonding in metal hydrides  
22 p0247 A79-21679
- MAKISHCHEVSKAYA, N. A.**  
Selection of a characteristic quantity defining the self-ignition of a fuel in a stream  
21 p0114 A79-16786
- MALLNER, C.**  
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[AD-A061071]  
22 p0342 A79-17341
- MALONEY, K. L.**  
Low-sulfur western coal use in existing small and intermediate size boilers  
[PB-287937/7]  
22 p0346 A79-18061
- MALOTT, J. P.**  
Potential producibility and recovery of natural gas from geopressured aquifers of the Cenozoic sediments of the Gulf Coast Basin  
[FE-2025-3]  
21 p0192 A79-11607
- MALYKHIN, A. I.**  
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22 p0235 A79-20530  
Production and application of rolling-welded aluminum alloy panels for solar water heaters for hot water and cooling systems  
22 p0297 A79-28670
- MAMANE, Y.**  
Oxidation of SO<sub>2</sub> on the surface of fly ash particles under low relative humidity conditions  
22 p0277 A79-26038
- MAMASSEN, J.**  
Polycrystalline CdSe-based photo-electrochemical cells  
21 p0037 A79-11785
- MANAUD, J. P.**  
A new thermochemical process for hydrogen production  
22 p0312 A79-31153
- MANCHESTER, D. F.**  
Development of an Air Force facilities energy information system  
[AD-A059309]  
21 p0223 A79-14918
- MANCHESTER, P. D.**  
Electronic states of concentrated Pd-B alloys from de Haas-van Alphen measurements  
22 p0248 A79-21686
- MANCINI, P. P.**  
Performance testing of a three ton solar absorption chiller  
[AIAA PAPER 78-1757]  
21 p0060 A79-13858
- MANCINI, T. R.**  
Performance evaluation of the New Mexico State University Solar House  
[ASME PAPER 78-WA/SOL-8]  
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- MANDA, M. L.**  
Power coupling alternatives for the NPP thermionic power system  
[NASA-CR-158372]  
22 p0367 A79-21547
- MANT, A.**  
Measurement of solar radiation for energy conversion  
21 p0119 A79-17305
- MANIKOPOULOS, C. M.**  
The advanced thermionic converter with microwave power as an auxiliary ionization source  
21 p0153 A79-18470
- MANISCALCO, J.**  
Electric power from laser fusion - The MYLIFE concept  
21 p0030 A79-10249  
Civilian applications of laser fusion  
[UCRL-52349]  
21 p0195 A79-12439
- MANN, J. W.**  
A comparison of the performance of steam turbine cycles using gas contaminated geothermal steam  
[ASME PAPER 78-WA/ENER-3]  
21 p0159 A79-19776
- MANTI, R. M.**  
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[ASME PAPER 78-WA/FU-9]  
21 p0160 A79-19789
- MANNAN, K. D.**  
Performance of optimal geometry three step compound wedge stationary concentrator  
21 p0134 A79-17438  
Design fabrication and testing of three meter diameter parabolic dish heliostat system  
21 p0135 A79-17447  
Design and performance of 1/4 H.P. solar power unit  
21 p0141 A79-17503  
Optimal geometries for one- and two-faced symmetric side-wall booster mirrors  
21 p0149 A79-18019
- MANNER, D.**  
An analytical expression for the specific output of wind turbine generators  
22 p0273 A79-25720
- MANNING, H. R.**  
Performance of molten salt sodium/beta-alumina/SbCl<sub>3</sub> cells  
22 p0245 A79-21479
- MANNY, R. H.**  
Combustion modifications for the control of air pollutant emissions from coal fired utility boilers  
[ASME PAPER 78-WA/APC-7]  
21 p0158 A79-19738
- MANOFF, H.**  
Solar Power Satellite thermal analysis  
21 p0003 A79-10028

- HANSFIELD, R. G.**  
The application of thermography to large arrays of solar energy collectors 22 p0242 A79-21171
- HANSHILIN, V. V.**  
Demetallization catalyst tests on heavy residual oils [PB-285937/9] 21 p0232 B79-15864
- HANVI, R.**  
Performance and economic risk evaluation of dispersed solar thermal power systems by Monte Carlo simulation 21 p0020 A79-10163
- HANZANO, J. J.**  
Cooling applications of thermic diode panels [ASME PAPER 78-WA/SOL-10] 21 p0163 A79-19842
- HAPLES, S.**  
A mass and energy balance of a Wellman-Galusha gasifier 22 p0283 A79-26467
- HAR, R. W.**  
Thermochemical energy storage and transport program [SAND-78-8056] 21 p0221 B79-14570
- HARATHE, B. R.**  
A new fabrication process for single crystal silicon solar cells 21 p0122 A79-17335  
Design and fabrication of silicon solar cells for concentrated light 21 p0124 A79-17352
- MARCHANT, D. D.**  
Development, characterization and evaluation of materials for open cycle MHD 22 p0361 B79-20504  
Development, characterization and evaluation of materials for open cycle MHD 22 p0369 B79-21557
- MARCHANT, L. C.**  
Oil recovery from a Utah tar sand deposit by in situ combustion 21 p0004 A79-10043
- MARCINIAK, T. J.**  
Integrating technologies to produce energy conservation [CONF-780109-6] 21 p0189 B79-11541
- MARCUSE, W.**  
Economic impacts of a transition to higher oil prices [BNL-50871] 22 p0364 B79-20927
- MARFISI, E. P.**  
Impact of electric passenger automobiles on utility system loads, 1985 - 2000 [EPRI-BA-623] 21 p0203 B79-13281
- MARGARITIS, P. J.**  
Process development for the Westinghouse advanced fluidized-bed coal gasification system 21 p0006 A79-10058
- MARGEN, P.**  
Central solar heat stations and the Studsvik Demonstration Plant 21 p0021 A79-10175
- MARIANOWSKI, L. G.**  
Partial processes and transport parameters in molten carbonate fuel cell operation 21 p0040 A79-11819
- MARICIC, D. L.**  
Advances in lower cost phosphoric acid fuel cells 21 p0010 A79-10092
- MARIE, J. P.**  
Solar houses in Blagnac /Blagnac, Haute-Garonne, France/ 22 p0276 A79-25937
- MARICIC, B.**  
Discharge reaction mechanisms in Li/SOCl<sub>2</sub> cells 22 p0305 A79-30331
- MARKIEWICZ, D.**  
Design of superconducting magnets for full-scale MHD generators 21 p0084 A79-15306
- MARROWITZ, T. B.**  
A cost effective vertical air/water solar heating collector 22 p0320 A79-31430
- MARNSBERRY, C. L.**  
The application of indirectly fired open cycle gas turbine systems utilizing atmospheric pressure fluidized bed combustors to industrial cogeneration situations [ASME PAPER 79-GT-16] 22 p0306 A79-30510
- MARNOVOORT, J. A.**  
The effect of thermo-electric forces on the density profiles in a thermonuclear plasma surrounded by a cold blanket 22 p0292 A79-27886
- MARLAND, G.**  
Net energy analysis of five energy systems [ORAU/IEA (B)-77-12] 21 p0174 B79-10534
- MARLOW, R.**  
Estimating heat loads on multistage thermoelectric heat pumps 22 p0260 A79-23614
- MARSHAR, B. S.**  
The effects of wall temperature on light impurities in Alcator 22 p0313 A79-31188
- MAROLLI, C.**  
Wave propagation and absorption near the electron-cyclotron layer in the 'THOR' device 22 p0271 A79-24867
- MARQUET, L. C.**  
Historical review of adaptive optics technology 21 p0114 A79-17171
- MARRIOTT, A. T.**  
JPL - Small Power Systems Applications Project 21 p0019 A79-10161
- MARROW, H. D.**  
Soot and the combined cycle boiler [ASME PAPER 79-GT-67] 22 p0307 A79-30533
- MARSH, B. O.**  
Structural cost optimization of photovoltaic central power station modules and support structure [ASME PAPER 79-SOL-17] 22 p0309 A79-30551
- MARSH, W. D.**  
Utility applications of wind power plants 21 p0092 A79-15882
- MARSHALL, B. W.**  
A status report on the Solar Thermal Test Facility 21 p0112 A79-16731
- MARSHALL, K. H.**  
An approximate equation for predicting the solar transmittance of transparent honeycombs 21 p0042 A79-11877
- MARSHALL, W. P.**  
Performance characteristics of automotive engines in the United States. First Series: Report No. 14 1975 Mazda Rotary 79 CID (1.1 liters), 4V [PB-286074/0] 21 p0226 B79-15304  
Performance characteristics of automotive engines in the United States. First series: Report no. 15 1975 Dodge Colt 98 CID (1.6 liters), 2V [PB-286075/7] 21 p0226 B79-15305  
Performance characteristics of automotive engines in the United States Third series: Report No. 1 1977 Volvo 130 CID (2.1 liters), P.I. [PB-286077/3] 21 p0227 B79-15307  
Performance characteristics of automotive engines in the United States. Second series, report no. 4: 1976 Chevrolet 85 CID (1.4 liters), IV [PB-286294/4] 21 p0227 B79-15308  
Performance characteristics of automotive engines in the United States. Second series, report no. 6: 1976 Nissan diesel 198 CID (3.2 liters), P. I: [PB-286295/1] 21 p0227 B79-15309  
Performance characteristics of automotive engines in the United States. Second series, report no. 7: 1977 Ford 171 CID (2.8 liters), 2V [PB-286296/9] 21 p0227 B79-15310  
Performance characteristics of automotive engines in the United States. First series, report no. 16: 1975 121 CID (2.0 liters), P.I. [PB-286297/7] 21 p0227 B79-15311  
Performance characteristics of automotive engines in the United States. First series, report no. 17: 1975 Buick 455 CID (7.5 liters), 4V [PB-286298/5] 21 p0227 B79-15312  
Performance characteristics of automotive engines in the United States. First series, report no. 18: 1976 Ford CID (6.6 liters), 2V [PB-286299/3] 21 p0227 B79-15313  
Performance characteristics of automotive engines in the United States. First series, report no. 19: 1975 Ford Windsor 351 CID (5.7 liters), 2V [PB-286300/9] 21 p0228 B79-15314

- Performance characteristics of automotive engines in the United States. First series, report no. 20: 1975 Chevrolet 350 CID (5.7 liters) with dresser variable-area venturi system [PB-286301/7] 21 p0228 A79-15315
- HARSTON, C. H.  
Fluids engineering in advanced energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978 22 p0278 A79-26176
- MARTIN, A. E.  
Calcium/iron sulfide secondary cells 21 p0041 A79-11835
- MARTIN, D.  
An assessment of mercury emissions from fossil fueled power plants [PB-285227/5] 21 p0213 A79-13592
- MARTIN, F. H.  
An inventory of environmental impact models related to energy technologies [ORNL/EIS-147] 22 p0372 A79-21640
- MARTIN, G. B.  
Emission control techniques for alternative fuel combustion 21 p0053 A79-12990  
Combustion modification pollutant control techniques for industrial boilers - The influence of fuel oil properties and atomization parameters [ASME PAPER 78-WA/APC-13] 21 p0159 A79-19742
- MARTIN, G. D.  
SLPX - Superconducting Long-Pulse Tokamak Experiment 22 p0237 A79-20557
- MARTIN, J. F.  
Design studies and trade-off analyses for a superconducting magnet/MHD power generator system 21 p0017 A79-10142
- MARTIN, J. H.  
Solar energy for residential housing 21 p0090 A79-15857
- MARTIN, J. W.  
Design considerations for an in situ gasification test of eastern bituminous coals 21 p0005 A79-10049
- MARTIN, R.  
An inexpensive multiplexer temperature measuring system for monitoring and evaluation of solar collectors 21 p0089 A79-15847
- MARTIN, R. E.  
Development of advanced fuel cell system [NASA-CR-159443] 21 p0196 A79-12553
- MARTIN, W. E.  
Performance of the short-pulse oscillators for Argus and Shiva 21 p0083 A79-15171
- MARTINELLI, M. R.  
A state of charge monitor for sealed lead-acid cells [ATR-78(8114)-2] 21 p0220 A79-14558
- MARTINEZ, R. H.  
Water/energy management and evaluation model for Pennsylvania [PB-287577/1] 22 p0343 A79-17353
- MARTINI, W. R.  
Energy conversion in the long run 21 p0019 A79-10154
- MARTINO, P. J.  
Advances in the development of lithium-aluminum/metal sulfide cells for electric-vehicle batteries 21 p0010 A79-10089
- MARTYNOV, M. A.  
Superconductivity in antenna engineering 22 p0311 A79-31008
- MARTZ, J.  
NASA Lewis Research Center photovoltaic application experiments [AIAA PAPER 78-1768] 24 p0061 A79-13867
- MARU, H. C.  
Heat transfer in phosphoric acid fuel cell stacks 21 p0010 A79-10091  
Partial processes and transport parameters in molten carbonate fuel cell operation 21 p0040 A79-11819
- MARUNNIC, P.  
Demetallization catalyst tests on heavy residual oils [PB-285937/9] 21 p0232 A79-15864
- MARDASAK, T. J.  
The matching of a free piston Stirling engine coupled with a free piston linear compressor for a heat pump application 21 p0024 A79-10204
- MARZEC, A.  
Bituminous coal extraction in terms of electron-donor and -acceptor interactions in the solvent/coal system 22 p0283 A79-26469
- MASICA, W. J.  
Thermal storage for industrial process and reject heat 22 p0243 A79-21300  
Thermal storage for industrial process and reject heat [NASA-TN-78994] 21 p0183 A79-11481  
The role of thermal energy storage in industrial energy conservation [NASA-TN-79122] 22 p0368 A79-21550
- MASKELL, W. C.  
Mathematics of coiling in cylindrical electrochemical cells - The theory of a spiral bounded by two circles and its application to the spiral-wound nickel-cadmium cell 22 p0246 A79-21489
- MASLENNIKOV, V. M.  
Protection of the biosphere 21 p0105 A79-16483
- MASON, J. J.  
Field performance of certain selective and neutral surfaces in solar collectors 21 p0131 A79-17417
- MASON, J. L.  
Flywheels for vehicles 21 p0092 A79-15885
- MASON, R.  
A literature review-problem definition studies on selected toxic chemicals. Volume 1: Occupational health and safety aspects of diesel fuel and white smoke generated from it [AD-A056018] 21 p0192 A79-11686
- MASS, E. A.  
Economic optimization of heatpump assisted solar heating in Illinois 21 p0072 A79-14691
- MASSIE, L. D.  
Military needs for orbital power 21 p0169 A79-10127
- MASTERSON, K. D.  
Optics applied to solar energy IV; Proceedings of the Seminar, San Diego, Calif., August 30, 31, 1978 22 p0293 A79-28140  
Optical design of a solar collector for the advanced solar thermal electric conversion/process heat program [Y/SUB-77/14261] 21 p0209 A79-13528
- MASUDA, M.  
Superconducting energy storage magnets 22 p0236 A79-20537
- MASUDA, Y.  
Wave power electric generation study in Japan 21 p0151 A79-18107
- MASUHARA, Y.  
Experimental studies of a linear MHD generator with fully ionized seed 22 p0238 A79-20796
- MATAYA, K.  
Cryogenic aspects of the U.S. SCMS superconducting dipole magnet for MHD research 21 p0084 A79-15303
- MATAYA, K. F.  
Design and operating experience of the cryogenic system of the U.S. SCMS as incorporated into the bypass loop of the U-25 MHD generator facility 22 p0235 A79-20532
- MATHEE, G. R., JR.  
Long-term average performance of the Sunpak evacuated-tube collector 21 p0089 A79-15854  
Analysis and experimental tests of a high-performance evacuated tubular collector [NASA-CR-150874] 22 p0334 A79-16370
- MATHEW, A. K.  
Active heat exchange system development for latent heat thermal energy storage [NASA-CR-159479] 22 p0368 A79-21554

- MATHUR, M. L.**  
Design, construction and performance of Fresnel lens for solar energy collection  
21 p0136 A79-17456
- MATHUR, P. C.**  
Temperature dependence of photovoltaic solar energy conversion for GaAs homojunction solar cell  
22 p0256 A79-22768
- MATHUR, S. S.**  
Preparation and properties of pure and tin doped indium oxide selective coatings  
21 p0127 A79-17381  
Some aspects towards the performance evaluation and ensuing design components of solar collector systems  
21 p0130 A79-17404  
Periodic heating/cooling by solar radiation  
21 p0140 A79-17491
- MATLIN, R. W.**  
25 kilowatt photovoltaic powered irrigation and grain drying experiment  
21 p0143 A79-17519  
Field tests of photovoltaic power systems [ASME PAPER 79-SOL-10]  
22 p0308 A79-30545
- MATSUI, R.**  
Solar heating performance of the Toshiba Solar House No. 1  
21 p0137 A79-17465
- MATTHESON, L.**  
Theory of the striated corona in a theta pinch  
22 p0295 A79-28315
- MATTHEWS, C. C.**  
Measured effects of flow leakage on the performance of the GT-225 automotive gas turbine engine  
[ASME PAPER 79-GT-3]  
22 p0306 A79-30502
- MATTHEWS, J. E.**  
Treatment of petroleum refinery, petrochemical and combined industrial-municipal wastewaters with activated carbon: Literature review  
[PB-288211/6]  
22 p0350 N79-18497
- MATTHEWS, L. K.**  
The USA 5MW solar thermal test facility  
21 p0135 A79-17449  
Solar thermal test facility experiment manual [SAND-77-1173]  
21 p0221 N79-14568
- MATTICK, A. T.**  
Absorption of solar radiation by alkali vapors  
21 p0108 A79-16612
- MATTINGLY, G. E.**  
Flow rate calibration for solar heating and cooling system evaluation  
21 p0089 A79-15845
- MATULA, R. A.**  
Combustion kinetics of selected aromatic hydrocarbons  
[AD-A059381]  
21 p0215 N79-14184
- MATVEEV, I. V.**  
Study of a heat exchanger with heat pipes within the system of a small-scale gas-turbine engine  
21 p0114 A79-16800
- MATVEEV, V. P.**  
Solar-to-thermal energy converter based on coaxial evacuated tubular elements with multilayer and selective coatings  
21 p0167 A79-20356
- MATKAMIN, R. L.**  
Performance evaluation of the New Mexico State University Solar House  
[ASME PAPER 78-WA/SOL-8]  
21 p0163 A79-19840
- MAXIMOVITCH, S.**  
A study of positive electrode materials for batteries operating in a halide-aluminate medium  
22 p0245 A79-21480
- MAXWELL, B.**  
Encapsulant materials for \$2/watt terrestrial photovoltaic arrays  
22 p0266 A79-24138
- MAXWELL, B. G.**  
Integral assembly of photovoltaic arrays using glass  
22 p0241 A79-20883
- MAXWELL, J. R.**  
The effect of maturation on the configuration of pristane in sediments and petroleum  
22 p0272 A79-25375
- MAYO, L. G.**  
Assessment of the potential of solar thermal small power systems in small utilities  
[NASA-CR-158093]  
22 p0335 N79-16377
- MAZRIA, B.**  
Predicting the performance of passive solar-heated buildings  
21 p0063 A79-13899
- MCALLES, D. G.**  
Characteristics of a predemonstration fusion device  
21 p0078 A79-14784
- MCALLEVY, R. F., III**  
A critical review and evaluation of published electric-vehicle performance data  
21 p0009 A79-1Q081
- MCALLISTER, A. J.**  
Materials for fuel cells  
[PB-285360/4]  
21 p0212 N79-13553
- MCBRENN, J.**  
The zinc electrode in sealed alkaline cells  
21 p0040 A79-11823
- MCBRIDE, D. A.**  
Risk control in the development of energy processes  
21 p0085 A79-15372
- MCBRIDE, J. B.**  
Quasi-linear theory of heat flow and diffusion in a tokamak  
22 p0270 A79-24859  
Theory of the striated corona in a theta pinch  
22 p0295 A79-28315
- MCBRYAR, R.**  
Technology status: Fuel cells and electrolysis cells  
21 p0170 N79-10133
- MCCAIN, J. D.**  
Evaluations of novel particulate control devices  
[PB-283973/6]  
21 p0199 N79-12601
- MCCALLUM, P. W.**  
The status of alcohol fuels utilization technology for highway transportation  
21 p0003 A79-10035
- MCCANDLESS, L. C.**  
Assessment of coal cleaning technology  
[PB-287091/3]  
22 p0330 N79-16139  
Assessment of coal cleaning technology: An evaluation of chemical coal cleaning processes  
[PB-289493/9]  
22 p0372 N79-21625
- MCCARTHY, J. E.**  
The Research-Cottrell/Bahco SO2 and particulate removal system at Rickenbacker Air Force Base  
21 p0065 A79-14122
- MCCHESENEY, R. H.**  
Solar heated and cooled financial building  
21 p0139 A79-17484
- MCCONNAUGHEY, J. S.**  
Life-cycle costing. A guide for selecting energy conservation projects for public buildings  
[PB-287804/9]  
22 p0345 N79-17744
- MCCONNELL, J. C.**  
Antimony, arsenic, and mercury in the combustible fraction of municipal solid waste  
[PB-285196/2]  
21 p0213 N79-13590
- MCCONNELL, J. F.**  
EPA program conference report: Coal cleaning, an option for Increased Coal Utilization  
[PB-288223/1]  
22 p0344 N79-17378
- MCCONNELL, R. D.**  
Validation of an electric circuit model of a solar house  
22 p0321 A79-31440
- MCCORMICK, K. H.**  
Engineering and bench-scale studies of the sulfur-iodine cycle at General Atomic  
21 p0015 A79-10127
- MCCORMICK, J. E.**  
Brayton Isotope Power System - The versatile dynamic power converter  
21 p0023 A79-10190
- MCCORMICK, H. E.**  
Wave energy conversion in a random sea  
21 p0030 A79-10252
- MCCORMICK, P. G.**  
The structure and properties of Cu based selective surfaces formed on an Al-Cu alloy by chemical brightening and etching treatments  
21 p0127 A79-17384
- MCCOY, B. C.**  
Evaluation of dry sorbents and fabric filtration for PGD (Flue Gas Desulfurization)  
[PB-289921/9]  
22 p0373 N79-21661
- MCCOY, F. W.**  
The use of ocean energy - A hydrostatic motor  
22 p0288 A79-27391

- MCCOY, L. R.  
Lithium silicon - Iron sulfide load-leveling and electric vehicle batteries 21 p0010 A79-10088
- MCCRACKEN, G. M.  
Review of results from DITE tokamak 21 p0069 A79-14456
- MCDONALD, C. F.  
The nuclear closed-cycle gas turbine /GT-HTGR/ - A utility power plant for the year 2000 [AIAA PAPER 79-0191] 21 p0157 A79-19590  
Large closed-cycle gas turbine plant [GA-A-14311] 22 p0331 N79-16261
- MCDONALD, R.  
Brookhaven National Laboratory burner-boiler/furnace efficiency test project. Annual fuel use and efficiency reference manual: hydronic equipment [BNL-50816] 21 p0210 N79-13538
- MCDONALD, T. E.  
Verification methodology for the DOE-1 building energy analysis computer program [LA-UR-78-1493] 21 p0208 N79-13520
- MCDUGAL, A. E.  
Design of a preprototype Stirling Laboratory Research Engine 21 p0024 A79-10203
- MCDOWELL, W. J.  
New processes for the recovery of resource materials from coal combustion wastes 21 p0007 A79-10065
- MCELHURRY, B.  
Economics of fuel gas from coal: An update including the British Gas Corporation's slagging gasifier [EPRI-AP-782] 21 p0180 N79-11238  
Economics of Texaco gasification: Combined cycle systems. Economic studies of coal gasification combined cycle systems for electric power generation [EPRI-AP-753] 21 p0185 N79-11498
- MCELEOY, J. E.  
Evaluation and optimization of Solid Polymer Electrolyte (SPE) fuel cells [AD-A058380] 21 p0206 N79-13505
- MCFADDEN, J. B.  
Energy supply and environmental impacts: Conventional sources, study module 3-A, technical appendix [PB-283787/0] 21 p0198 N79-12573
- MCFARLAND, D. R.  
Investigation of a staged plasma-focus apparatus 22 p0255 A79-22365
- MCFARLAND, R. D.  
Passive solar heating of buildings [LA-UR-77-1162] 21 p0090 A79-15859  
Passive solar heating of buildings 22 p0275 A79-25928
- MCGARITY, A. E.  
Solar heating of buildings: Design optimization and economic analysis 22 p0353 N79-19439
- MCGILL, J.  
The interfacial layer in MIS amorphous silicon solar cells 22 p0258 A79-23039
- MCGOWAN, J. G.  
Advanced wind furnace systems for residential and agricultural heating and electrical supply applications 21 p0028 A79-10237  
Development of compact heat exchangers for Ocean Thermal Energy Conversion /OTEC/ systems [ASME PAPER 78-WA/HT-34] 21 p0161 A79-19815  
Flow modeling of an atmospheric pressure, entrained-type coal gasifier 22 p0280 A79-26188
- MCHARDY, J.  
O2 reduction kinetics in concentrated acids 21 p0038 A79-11809
- MCHUGH, J. P.  
Silicon web process development [NASA-CR-158376] 22 p0357 N79-20282
- MCINTYRE, W. B.  
On the design of CPC photovoltaic solar collectors 21 p0124 A79-17355
- MCINTOSH, G. E.  
Refrigeration requirements for future superconductive energy related applications 22 p0311 A79-31019
- MCINTYRE, J. D. E.  
Symposium on Electrode Materials and Processes for Energy Conversion and Storage, Philadelphia, Pa., May 9-12, 1977, Proceedings 21 p0036 A79-11776
- MCINTYRE, J. F.  
Definition of chemical and electrochemical properties of a fuel cell electrolyte [AD-A058795] 21 p0206 N79-13503
- MCKAY, D. C.  
The role of applied meteorology in the Canadian energy programme 22 p0317 A79-31414
- MCKENZIE, D. R.  
Gold, silver, chromium, and copper cermet selective surfaces for evacuated solar collectors 22 p0256 A79-22855
- MCKHANE, G.  
The 100 kW space station 22 p0371 N79-21603
- MCKIEL, G.  
Solar energy retrofit system for an older-type building - The Williamstown Museum project 22 p0320 A79-31434
- MCKINZIE, G. A.  
Economy in flight operations 21 p0048 A79-12383
- MCKNIGHT, D.  
Development of a compact gas turbine combustor to give extended life and acceptable exhaust emissions [ASME PAPER 78-GT-146] 21 p0033 A79-10799
- MCLALLIN, K. L.  
Cold-air performance of free power turbine designed for 112-kilowatt automotive gas-turbine engine. 2: Effects of variable stator-vane-chord setting angle on turbine performance [NASA-TN-78993] 22 p0345 N79-17859
- MCLAREN, G. W.  
Further studies of fuels from alternate sources: Fire extinguishment experiments with JP-5 jet turbine fuel derived from shale [AD-A058586] 21 p0201 N79-13182
- MCLAUGHLIN, E. R.  
Experience gained and lessons learned from monitoring the solar building, Albuquerque 21 p0088 A79-15833
- MCLAUGHLIN, J. F.  
Determination of the potential for solar retrofitting in Edmonton 22 p0323 A79-31456
- MCHURPHY, F. E.  
Bibliographic and numeric data bases for fiber composites and matrix materials 21 p0114 A79-16984
- MCHAHARA, B.  
Single-particle behaviour in plasmas 22 p0257 A79-22977
- MCHAHARA, T. J.  
A solar energy system for space heating and space cooling 21 p0072 A79-14686
- MCHICHOLES, J. L.  
Nitinol heat engines for economical conversion of low grade thermal density 21 p0027 A79-10230  
Low-grade thermal energy-conversion Joule effect heat engines [ASME PAPER 78-ENAS-7] 21 p0048 A79-12556  
Thermoclines: A solar thermal energy resource for enhanced hydroelectric power production 22 p0237 A79-20730
- MCHVEY, B. D.  
A ray-tracing analysis of fast-wave heating of tokamaks 22 p0313 A79-31186
- MCHILLIAMS, D. A.  
Design and operating experience of the cryogenic system of the U.S. SCMS as incorporated into the bypass loop of the U-25 MHD generator facility 22 p0235 A79-20532
- MHAD, G. R.  
Energy education training: Feasibility study [PB-285910/6] 21 p0230 N79-15428

## PERSONAL AUTHOR INDEX

MEYER, B. A.

- MEADER, D. E.  
Magnetohydrodynamic lightweight channel development  
[AD-A060429] 21 p0230 A79-15414
- MEAGHER, J. F.  
The oxidation of sulfur dioxide to sulfate  
aerosols in the plume of a coal-fired power plant  
21 p0076 A79-14757
- MEAKIN, J. D.  
Recent progress in thin film polycrystalline solar  
cells based on cadmium sulfide 21 p0042 A79-11966  
The design and fabrication of CdS/Cu<sub>2</sub>S cells of  
8.5-percent conversion efficiency 22 p0300 A79-29428  
Low cost thin-film CdS-based solar cells progress  
and promise [ASME PAPER 79-SOL-15] 22 p0309 A79-30549
- MEDIN, S. A.  
Subsonic flow in the channel of an MHD-generator  
21 p0167 A79-20413  
Comparison of results of calculation of flow in an  
MHD generator with experimental data obtained on  
the U-25 device 22 p0306 A79-30392
- MEHROTRA, R. K.  
Design of solar heating system for winter heating  
of buildings /A case study/ 21 p0139 A79-17486
- MEHTA, D. C.  
Catalyst aging tests and the role of catalyst  
wetting on hydrodesulfurization of a coal  
derived liquid 22 p0352 A79-19169
- MEHTA, G. D.  
Assessment of the potential of generating power  
from aqueous saline solutions by means of  
Osmo-Hydro Power systems 21 p0016 A79-10133
- MEI, J. S.  
Fluidized-bed combustion of low-quality fuels  
21 p0007 A79-10066  
Fluidized-bed combustion test of low-quality  
fuels: Texas lignite and lignite refuse  
[MERC/RI-78/3] 21 p0175 A79-10543
- MEIR, G. H.  
Hot corrosion of Ni-base turbine alloys in  
atmospheres in coal-conversion systems 22 p0288 A79-27395
- MEIR, P.  
Assessment of the solid waste impact of the  
National Energy Plan [BNL-50708] 21 p0213 A79-13572
- MEIR, R. L.  
Urbanism and energy in developing regions  
[LBL-7808] 21 p0189 A79-11540
- MEIR, W.  
Electric power from laser fusion - The MYLIFE  
concept 21 p0030 A79-10249
- MEIJER, R. J.  
Conceptual design of a variable displacement  
Stirling engine for automotive propulsion 21 p0025 A79-10207
- MEIWEL, A. B.  
Optical design of a solar collector for the  
advanced solar thermal electric  
conversion/process heat program [Y/SUB-77/14261] 21 p0209 A79-13528
- MEINHOLD, H.  
Recent advances in Na/S cell development - A review  
22 p0246 A79-21488
- MEIR, W.  
Civilian applications of laser fusion  
[UCRL-52349] 21 p0195 A79-12439
- MELIKIAN, G.  
Analysis and design of an 18-ton solar-powered  
heating and cooling system 21 p0019 A79-10156
- MELISS, M.  
Potential and technical utilization of renewable  
energy sources 21 p0058 A79-13655
- MELLOR, A. H.  
Ignition/stabilization/atomization - Alternative  
fuels in gas turbine combustors 21 p0052 A79-12982  
A characteristic time correlation for combustion  
inefficiency from alternative fuels  
[AIAA PAPER 79-0357] 21 p0158 A79-19687
- MELLOR, G. L.  
Some flow analyses for Tornado-type wind turbines  
22 p0279 A79-26181
- MELSHEIMER, S. S.  
Heat transfer and calorimetric studies of a direct  
contact-latent heat energy storage system 22 p0281 A79-26210
- MENDELSON, M. H.  
Absorption of hydrogen by the intermetallics Ni<sub>3</sub>Sn  
and LaNi<sub>5</sub> and a correlation of cell volumes  
and desorption pressures 21 p0038 A79-11804  
BYCSOS - A system for evaluation of hydrides as  
chemical heat pumps 22 p0252 A79-21716
- MENTLEY, D.  
Development of economical improved thick film  
solar cell contact [NASA-CR-158358] 22 p0359 A79-20486
- MERCURE, R. A.  
Some design considerations of automotive gas  
turbines [SAE PAPER 790128] 22 p0314 A79-31360
- MEREDITH, D. B.  
Performance of residential solar heating and  
cooling system with flat-plate and evacuated  
tubular collectors - CSO Solar House I 22 p0276 A79-25939
- MEREDITH, G. O. G.  
Evaluation of high performance evacuated tubular  
collectors in a residential heating and cooling  
system: Colorado State University Solar House 1  
[COO-2577-14] 21 p0206 A79-13507
- MERGES, V.  
Evacuated solar flat-plate collectors for economic  
applications 21 p0133 A79-17435
- MERRIAM, H. F.  
Wind, waves, and tides 21 p0074 A79-14719
- MERRIAM, R. L.  
A computer simulation model for determining  
preferred solar heating and cooling systems 22 p0267 A79-24313
- MERRILL, O. S.  
The Department of Energy's thermionic energy  
conversion program 21 p0025 A79-10213  
Increasing the efficiency of coal-fired steam  
electric plants with thermionic topping 21 p0096 A79-15921
- MESEROLE, P. B.  
Trace element emissions from coal-fired power plants  
[ASME PAPER 78-WA/FU-9] 21 p0160 A79-19789
- MESCHERIAKOV, E. A.  
Combustion of hydrogen in a supersonic flow in a  
channel in the presence of a pseudodiscontinuity  
22 p0324 A79-31845
- MESICH, F. G.  
Sampling and analysis of synthetic fuel processes  
22 p0284 A79-26538
- MESSIAH, A. H.  
Magneto-acoustic resonance heating in the  
ion-cyclotron frequency domain 22 p0271 A79-24866
- MESSLER, R.  
Black germanium solar selective absorber surfaces  
22 p0327 A79-31970
- MEtz, F. E.  
State-of-the-art study of heat exchangers used  
with solar assisted domestic hot water systems  
(potential contamination of potable water supply)  
[PB-287410/5] 22 p0343 A79-17351
- MEUNIER, G.  
A new thermochemical process for hydrogen production  
22 p0312 A79-31153
- MEYER, A. P.  
Development of advanced fuel cell system  
[NASA-CR-159443] 21 p0196 A79-12553
- MEYER, B. A.  
An interferometric investigation heat transfer in  
honeycomb solar collector cells 21 p0129 A79-17398  
Natural convection heat transfer in small and  
moderate aspect ratio enclosures - An  
application to flat plate collectors 22 p0281 A79-26206



- MEYER, C. F.  
Large-scale thermal energy storage for  
cogeneration and solar systems 21 p0092 A79-15886
- MEYER, H.  
Wind energy 22 p0287 A79-27327
- MEYER, H. R.  
Nonproliferation Alternative Systems Assessment  
Program (NASAP): Preliminary environmental  
assessment of thorium/uranium fuel cycle systems  
[ORNL/TM-6069] 21 p0192 N79-11570
- MEYERS, A. C.  
Design considerations of small solar collector  
systems using plane heliostats  
[ASME PAPER 79-SOL-2] 22 p0307 A79-30540
- MEYERS, A. C., III  
Net energy analysis and environmental aspects for  
solar tower central receiver systems. I -  
Methodology 21 p0097 A79-16101
- MEYERS, R. A.  
Applicability of the Meyers process for  
desulfurization of U.S. coal - A survey of 35  
coals 21 p0044 A79-12117  
Coal desulfurization test plant status - July 1977  
21 p0044 A79-12118
- MIAO, D.  
Initial comparison of single cylinder Stirling  
engine computer model predictions with test  
results [SAE PAPER 790327] 22 p0315 A79-31368  
Initial comparison of single cylinder Stirling  
engine computer model predictions with test  
results [NASA-TM-79044] 22 p0337 N79-16721
- MICHAEL, G. J.  
Development of gas turbine performance seeking logic  
[ASME PAPER 78-GT-13] 21 p0031 A79-10257
- MICHAELIS, D.  
Long-term thermal storage in solar architecture in  
northern latitudes, with reference to typical  
single family dwellings 21 p0119 A79-17313
- MICHAL, C. J.  
Passive solar design 21 p0074 A79-14720
- MICHALOPOULOS, P. G.  
Bus priority system studies 22 p0299 A79-29339
- MICHALSKY, J. J.  
Differential insolation and turbidity measurements  
22 p0241 A79-21056
- MICHEL, A. P. J.  
Conceptual design of a variable displacement  
Stirling engine for automotive propulsion  
21 p0025 A79-10207
- NICKELSEN, R. A.  
Improved semiconductors for photovoltaic solar cells  
[DSE/2459-2] 21 p0221 N79-14577
- NICKLE, E. H.  
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modeling - Ecological and biomedical modeling.  
Part 2 - Socioeconomic modeling. Part 3 -  
Control and identification. Part 4 Methodology  
and applications 22 p0263 A79-23776
- MIDDLETON, R. L.  
The Solar Heating and Cooling Commercial  
Demonstration Program at Marshall Space Flight  
Center - Some problems and conclusions 21 p0099 A79-16135
- NIEDEN, A. R.  
Model predictions for the stability of ternary  
metallic hydrides 21 p0038 A79-11802  
Hydrogen absorption in rare earth intermetallic  
compounds 22 p0249 A79-21693  
Some applications of LaNi5-type hydrides  
22 p0249 A79-21694
- NIEWTEK, A. P.  
Advances in lower cost phosphoric acid fuel cells  
21 p0010 A79-10092
- NIGLIORE, P. G.  
Some effects of flow curvature on the performance  
of Darrieus wind turbines  
[AIAA PAPER 79-0112] 21 p0156 A79-19538
- NIKESELL, R. D.  
The Garrett Energy Research biomass gasification  
process 21 p0004 A79-10037
- NIKHAHL, A.  
Generic power performance estimates for wind  
turbines 21 p0068 A79-14295
- NIKHAHL, A. S.  
Energy statistics for large wind turbine arrays  
22 p0299 A79-29371
- NIKHAILOV, V. I.  
Superconductivity in antenna engineering  
22 p0311 A79-31008
- NIKHAILOVSKII, I. K.  
Laser measurements of the radial profiles of the  
electron temperature and density in the FT-1  
tokamak 22 p0244 A79-21430
- NIKHALEVICH, V. S.  
Determining optimal angles of nonconvex solar  
battery panel mounting 21 p0080 A79-14837
- NIKKOR, H.  
Pulse characteristics of sodium sulfur cells for  
electric vehicle propulsion 21 p0009 A79-10082
- NIKOLOWSKI, W. T.  
The potential of liquid hydrogen as a military  
aircraft fuel 22 p0238 A79-20773
- NIKRUKOV, CH. K.  
Optimality criteria in the compensation of the  
longitudinal boundary effect in induction MHD  
machines 22 p0298 A79-29277
- NILBORROW, D. J.  
Performance prediction methods for horizontal axis  
wind turbines 21 p0045 A79-12244
- NILES, C. R.  
Thermosyphon models for downhole heat exchanger  
applications in shallow geothermal systems  
21 p0150 A79-18092
- NILES, R. F., JR.  
Thermal power systems small power systems  
applications project. Decision analysis for  
evaluating and ranking small solar thermal power  
system technologies. Volume 1: A brief  
introduction to multiattribute decision analysis  
[NASA-CR-158425] 22 p0368 N79-21548
- NILEY, G. H.  
Progress in nuclear-pumped lasers 21 p0110 A79-16627  
Particle orbits in field-reversed mirrors  
22 p0253 A79-22239
- NILKINS, E. E.  
Some problems and benefits from the hydrogen  
fueled spark ignition engine 21 p0016 A79-10130
- HILLAR, W.  
Heating and confinement in the CLEO stellarator  
21 p0070 A79-14459
- HILLER, B.  
Semiconductor liquid junction solar cells -  
Efficiency, electrochemical stability, and  
surface preparation 21 p0037 A79-11783
- HILLER, C. G.  
Primary reflector for solar energy collection  
systems  
[NASA-CASE-NPO-13579-4] 21 p0217 N79-14529
- HILLER, D. L.  
On an irreversible thermodynamic analysis of  
thermoelectric devices 22 p0260 A79-23609
- HILLER, G.  
Heat exchanger designs for coal-fired fluidized beds  
21 p0009 A79-10079  
Recent developments in pressurized fluidized bed  
coal combustion research  
[AIAA PAPER 79-0190] 21 p0157 A79-19589

- HILLER, J. D.**  
Measurement and control techniques in geothermal power plants [TREE-1312] 22 p0362 H79-20508
- HILLER, J. R.**  
A new method for producing cryogenic laser fusion targets 21 p0085 A79-15332
- HILLER, J. W.**  
Electricity from sunlight 21 p0065 A79-14116
- HILLER, K. R.**  
Construction of a 10GWe solar power satellite 21 p0003 A79-10029
- HILLER, M.**  
The energy dilemma: A challenge for Maryland. Proceedings Maryland General Assembly/AISLE Conference [PB-284703/6] 21 p0199 H79-12579
- HILLER, R. C.**  
A high-efficiency GaAs double-heterostructure photovoltaic detector 21 p0154 A79-18489
- HILLER, R. W.**  
Design of a second generation concentrating tracking solar collector [AIAA PAPER 78-1775] 21 p0062 A79-13872  
A flat plate multiple pass solar collector using aqueous optical properties 22 p0293 A79-28144  
A parabolic solar reflector for accurate and economic producibility 22 p0293 A79-28145
- HILLER, W. R.**  
Review of industrial participation in the ANL lithium/iron sulfide battery development program 21 p0010 A79-10086
- HILLNER, A. R.**  
A flywheel energy storage and conversion system for solar photovoltaic applications [ASME PAPER 79-SOL-1] 22 p0307 A79-30539  
Flywheel components for satellite applications [AD-A060586] 21 p0226 H79-15145
- HILLS, D. R.**  
Manufacture of curved glass mirrors for linear concentrators 21 p0136 A79-17459  
Ideal prism solar concentrators 21 p0149 A79-18023  
The place of extreme asymmetrical non-focussing concentrators in solar energy utilization 21 p0149 A79-18024  
Symmetrical and asymmetrical ideal cylindrical radiation transformers and concentrators 22 p0303 A79-29647
- HILOVANOVA, W. A.**  
Study of photoelectric characteristics of photocells made from high-resistivity silicon 22 p0296 A79-28666
- HINARDI, E.**  
Integral invariants and quasi-BHD nonlinear dissipation 22 p0270 A79-24862
- HINARDI, J. E.**  
The Madaras Rotor Power Plant - An alternate method for extracting large amounts of power from the wind [AIAA PAPER 79-0115] 21 p0157 A79-19541
- HINASYAN, R.**  
Use of waste heat from thermal electric power plants and nuclear power plants to heat greenhouses [ORNL-TR-4483] 21 p0221 H79-14574
- HINCK, R. W.**  
Pulse characteristics of sodium sulfur cells for electric vehicle propulsion 21 p0009 A79-10082
- HINDER, R.**  
A solar heating and cooling system for an industrial plant located in southern Europe 21 p0139 A79-17480
- HINOH, A.**  
Development of high temperature fuel cell battery [BNPT-PB-T-77-17] 22 p0342 H79-17344
- HIRAKHUR, R. K.**  
A simple solar tracking system 21 p0136 A79-17457
- HIRSAGATOV, SH. A.**  
Photoelectric properties of pCdTe-nCdS film heterojunctions 21 p0166 A79-20347  
Calculating the photocurrent and maximum efficiency of film p-CdTe-n-CdS photocells 21 p0166 A79-20354
- HISHIMA, J.**  
Measured air flow rates through microorifices and flow prediction capability [PB-286868/5] 21 p0217 H79-14344
- HISHKIN, E. A.**  
Analysis of a cylindrical imploding shock wave 21 p0155 A79-18846
- HISHBA, R. K.**  
Harvesting solar energy using biological systems 21 p0126 A79-17372
- HISKOLCZY, G.**  
Lithium and potassium heat pipes for thermionic converters 21 p0013 A79-10113  
Characteristics of combustion-heated thermionic diodes 21 p0026 A79-10215
- HISSIG, J. R.**  
Applications of cryogenic technology. Volume 7 - Proceedings of the Conference on Cryogenic Energy Systems, Oak Brook, Ill., May 16-18, 1978 22 p0289 A79-27651
- MITCHELL, D. J.**  
Test procedures for the determination of the gross caloric value of refuse and refuse-derived-fuels by oxygen bomb calorimetry: Summary of the 1977 fiscal year results [PB-290160/1] 22 p0364 H79-21167
- MITCHELL, J.**  
Thermal storage and heat transfer in solar energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978 22 p0280 A79-26201
- MITCHELL, J. T. D.**  
The impact of servicing requirements on tokamak fusion reactor design 21 p0079 A79-14793
- MITCHELL, J. W.**  
Simulations of the performance of open cycle desiccant systems using solar energy 21 p0066 A79-14262  
An interferometric investigation heat transfer in honeycomb solar collector cells 21 p0129 A79-17398  
Natural convection heat transfer in small and moderate aspect ratio enclosures - An application to flat plate collectors 22 p0281 A79-26206  
Performance of combined solar-heat pump systems 22 p0285 A79-26817
- MITCHELL, K. B.**  
Two-dimensional monochromatic X-ray imaging of laser-produced plasmas 22 p0296 A79-28366
- MITCHELL, W. C.**  
Selenide thermoelectric converter technology 21 p0026 A79-10221
- MITO, S.**  
The development of photovoltaic conversion systems with sunlight concentration 21 p0148 A79-17995
- MITOFF, S. P.**  
Development of sodium-sulfur batteries for utility application [EPRI-EM-683] 21 p0186 H79-11502
- MITRA, S. S.**  
Characterisation of amorphous semiconductor materials for solar cell applications 21 p0123 A79-17341
- MITRISHKIN, IU. V.**  
Optimizing the conversion mode for solar energy 22 p0258 A79-23125
- MITSUI, A.**  
Photoproduction of hydrogen by marine blue-green algae [PB-287508/6] 22 p0343 H79-17354
- NIXON, P. O.**  
Pollutants from synthetic fuels production: Facility construction and preliminary tests [PB-287730/6] 22 p0339 H79-17027

- HIYASAKA, T.  
Highly efficient quantum conversion at chlorophyll  
a-lecithin mixed monolayer coated electrodes  
22 p0273 A79-25548
- HIYAZAKI, T.  
Wave power electric generation study in Japan  
21 p0151 A79-18107
- HIZUTA, S.  
The thermochemical decomposition of water using  
bromine and iodine  
22 p0238 A79-20770
- HLAVSKY, A. I.  
Optics applied to solar energy conversion;  
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21 p0042 A79-11965
- HODARRESI, K.  
The interaction of the wind field with a  
horizontal axis wind turbine  
22 p0278 A79-26177
- HODESTOV, A. V.  
Mass transfer in a current source during  
circulation of the mixture driven by gaseous  
reaction products  
21 p0164 A79-19851
- HODI, V. J.  
Transient attitude dynamics of satellites with  
deploying flexible appendages  
21 p0047 A79-12325
- HODJESKI, H.  
A superconducting dipole magnet for the UTISI MHD  
Facility  
22 p0235 A79-20533
- HODLINGER, A.  
Procedure for flight guidance in the terminal  
maneuvering area for an experimental program  
employing a flying test device  
21 p0147 A79-17680
- HOKLER, C. E.  
1MW calorimetric receiver for Solar Thermal Test  
Facility  
[ASME PAPER 78-WA/SOL-7]  
21 p0163 A79-19839
- HOFFITT, J. V.  
Direct utilization of crude oil as fuel in the US  
Army four-cycle diesel engine, model LDT-465-1C  
[AD-A062387]  
22 p0357 N79-20279
- HOHR, P. B.  
Preliminary design of a subscale ceramic  
helical-rotor expander  
21 p0050 A79-12849
- HOILANEN, G. L.  
Low-sulfur western coal use in existing small and  
intermediate size boilers  
[PB-287937/7]  
22 p0346 N79-18061
- HOIR, R. W.  
Mirror fusion reactors  
21 p0018 A79-10148
- HOK, Y.  
Electrons of high perpendicular energy in the  
low-density regime of tokamaks  
22 p0270 A79-24852
- HOLL, H. G.  
The Dow Chemical liquefaction process  
21 p0147 A79-17644
- HOLLOW, J. K.  
Advanced air transport concepts  
22 p0312 A79-31121
- BOLTON, P. H.  
Chemical production from waste carbon monoxide:  
Its potential for energy conservation  
[BNWL-2137]  
21 p0170 N79-10179
- HONOTA, H.  
Lower hybrid resonance heating  
22 p0271 A79-24865
- HONYER, W. R.  
Development and evaluation of a 600-kWh  
lithium-hydrogen peroxide reserve power system  
21 p0011 A79-10095
- HONAGHAN, P. Y.  
Design study on solar energy systems for  
commercial buildings  
22 p0320 A79-31433
- HONETTA, D. J.  
Improved Conversion Efficiency Workshop. Volume 2:  
Summary  
[CONF-771003-P2-VOL-2]  
21 p0176 N79-10551
- HONSLER, H.  
Electric power from laser fusion - The HYLIFE  
concept  
21 p0030 A79-10249
- Civilian applications of laser fusion  
[UCRL-52349]  
21 p0195 N79-12439
- HONSON, D. J.  
Systems efficiency and specific mass estimates for  
direct and indirect solar-pumped closed-cycle  
high-energy lasers in space  
21 p0110 A79-16623
- MONTAGNA, J. C.  
Limestone SO<sub>2</sub> reactivity and causes for reactivity  
loss during multi cycle utilization  
21 p0065 A79-14121
- HONTGONERY, D. B.  
Superconducting magnets  
21 p0105 A79-16485
- The Alcator liquid nitrogen-cooled tokamaks  
22 p0290 A79-27668
- HONTICKLO, D. A.  
Non-linear numerical algorithms for studying  
tearing modes  
22 p0257 A79-22981
- HONZA, E.  
Selective covers for natural cooling devices  
22 p0272 A79-25522
- HOON, B. L.  
High performance GaAs photovoltaic cells for  
concentrator applications  
[SAND-78-7018]  
21 p0187 N79-11521
- MOORE, B., III  
Environmental impacts of industrial energy systems  
in the coastal zone  
21 p0075 A79-14722
- MOORE, C. K.  
Economic evaluation of the ATC/Wellman  
incandescent two-stage low Btu coal gas producer  
21 p0146 A79-17640
- MOORE, D.  
Simulated hail impact testing of photovoltaic  
solar panels  
21 p0098 A79-16116
- MOORE, E.  
The production of solar cell grade silicon from  
bromosilanes  
[NASA-CR-158362]  
22 p0358 N79-20482
- MOORE, H. P.  
Synthetic oil from coal - The economic impact of  
five alternatives for making hydrogen from coal  
and steam  
22 p0262 A79-23719
- MOORTHY, P. M.  
Direct photoelectrochemical conversion and storage  
of solar energy  
21 p0126 A79-17370
- MOOS, H. W.  
Evidence for neutral-beam-injected oxygen  
impurities in 2XIB  
22 p0292 A79-27887
- The effects of wall temperature on light  
impurities in Alcator  
22 p0313 A79-31188
- MORAN, W. A.  
Giro mill wind tunnel test and analysis, volume 2.  
Technical discussion  
[COO-2617-4/2]  
21 p0204 N79-13378
- MORAN, W. P.  
A microprocessor based solar monitoring system  
21 p0088 A79-15838
- MORE, E. B.  
Design, fabrication, and test of a composite  
material wind turbine rotor blade  
[NASA-CR-135389]  
21 p0173 N79-10525
- MORELO, L.  
Piat Research Center hybrid vehicle prototype  
[SAE PAPER 790014]  
22 p0313 A79-31351
- MORETTI, V. C.  
A technical analysis for cogeneration systems with  
potential applications in twelve California  
industrial plants  
21 p0011 A79-10099
- MORGAN, C.  
A comparison of solar thermal energy collection  
using fixed and tracking collectors  
22 p0293 A79-28146

- MORGAN, J. D.  
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- MORGAN, L. L.  
Laser power conversion system analysis, volume 1  
[NASA-CR-159523-VOL-1] 22 p0366 H79-21334  
Laser power conversion system analysis, volume 2  
[NASA-CR-159523-VOL-2] 22 p0366 H79-21335
- MORIKAWA, J.  
200-kv Blumlein transmission line for ultrafast  
toroidal theta-pinch  
22 p0297 A79-28917
- MORITZ, P. S.  
Metal hydride solar heat pump and power system  
/HYCSOS/  
[AIAA PAPER 78-1762] 21 p0061 A79-13863
- MOSEDOV, G. E.  
MHD power plant characteristics  
21 p0105 A79-16480  
Layout and design characteristics of MHD power  
stations 21 p0105 A79-16481  
Steam generator and turbomachines 21 p0106 A79-16489
- MORRIS, G. E.  
Mining earth's heat - Hot dry rock geothermal energy  
22 p0258 A79-23280
- MORRIS, J. F.  
Diminutive thermionic energy conversion with  
lanthanum-hexaboride electrodes  
21 p0053 A79-13098
- MORRISON, C. A.  
The design and evaluation of a hydraulic-solar  
powered tracking device  
21 p0136 A79-17458  
Theoretical basis and design for a residential  
size solar powered ammonia/water absorption air  
conditioning system 21 p0139 A79-17479  
An experimental evaluation of an intermittent  
cycle solar-powered ammonia/water absorption air  
conditioning system 21 p0139 A79-17481
- MORRISON, L. R., JR.  
The economics of hydrogen and carbon monoxide  
separation with cuprous ammonium lactate solutions  
22 p0299 A79-29313
- MORROW, A. J.  
A review of the PFBC combined cycle and its  
influence on gas turbine design parameters  
21 p0007 A79-10067
- MORSE, F. H.  
Prospects for solar heating and cooling in the  
United States  
22 p0275 A79-25929
- MORTENSEN, J. J.  
Hot dry rock - A new geothermal energy source  
21 p0087 A79-15673
- MOSCHITTO, R. D.  
Operation of the Ft. Lewis, Washington Solvent  
Refined Coal /SRC/ Pilot Plant in the SRC I and  
SRC II processing modes  
21 p0006 A79-10054
- MOSCHOPEDIS, S. E.  
Factors affecting bitumen recovery by the hot  
water process  
22 p0282 A79-26463
- MOSER, R. E.  
Assessment of current flue gas desulfurization  
technology  
21 p0145 A79-17637
- MOSES, C. A.  
Effects of fuel properties on soot formation in  
turbine combustion  
[SAE PAPER 781026] 22 p0274 A79-25899
- MOSES, G. A.  
Pellet X-ray spectra for laser fusion reactor  
designs  
22 p0291 A79-27878
- MOSHIER, D.  
Microstability of a focused ion beam propagating  
through a z-pinch plasma  
22 p0270 A79-24817
- MOSIN, I. I.  
Study of a heat exchanger with heat pipes within  
the system of a small-scale gas-turbine engine  
21 p0114 A79-16800
- MOSTINSKII, I. L.  
Ionizing seed  
21 p0106 A79-16490
- MOTLEY, E.  
Catalytic conversion of coal energy to hydrogen  
[FE-2206-14] 21 p0180 H79-11239
- MOUNTE, J. H.  
The photogalvanovoltaic cell  
21 p0066 A79-14264
- MOVFORTH, E.  
The Sunship  
22 p0254 A79-22324
- MOZKICO, H. V.  
Control of wind turbine generators connected to  
power systems  
21 p0086 A79-15574
- MOZER, C. J.  
Experimental measurements and correlations of  
Nusselt number for MHD high temperature air  
preheaters  
[ASME PAPER 78-WA/HT-22] 21 p0161 A79-19809
- MRHA, J.  
Influence of the electrolyte content of oxygen  
carbon gas-diffusion electrodes on their  
electro-chemical performance in acid solutions  
22 p0245 A79-21483
- MUEHLHAUSER, J. W.  
Controlling NOx from a coal-fired MHD process  
21 p0017 A79-10139  
Design studies and trade-off analyses for a  
superconducting magnet/MHD power generator system  
21 p0017 A79-10142
- MUELLER, H.-G.  
Road vehicles with combined, at least partly  
electrical driving systems and energy supplies  
22 p0301 A79-29494
- MUELLER, L. J.  
Jet impingement solar air heater  
[AIAA PAPER 78-1760] 21 p0061 A79-13861
- MUELLER, H. H.  
The cryogenic heat transfer tunnel - A new tool  
for convective research  
22 p0267 A79-24316
- MUELLER, R. O.  
The interface with solar - Alternative auxiliary  
supply systems  
21 p0137 A79-17468
- MUKHERJEE, D.  
Investigation on junction formation and  
realisation of high open-circuit voltage in  
Cu/x/S-CdS solar cells  
21 p0123 A79-17344
- MUKHERJEE, M. K.  
Investigation on junction formation and  
realisation of high open-circuit voltage in  
Cu/x/S-CdS solar cells  
21 p0123 A79-17344  
A diagnostic study on the polycrystalline nature  
and its relationship with the yield of CdS solar  
cell  
21 p0125 A79-17361
- MUKHERJEE, S.  
Investigation on junction formation and  
realisation of high open-circuit voltage in  
Cu/x/S-CdS solar cells  
21 p0123 A79-17344
- MUKHOPADHYAY, K.  
Role of the diode exponential factor in CdS solar  
cells  
21 p0123 A79-17348
- MULCAHEY, T.  
Coal liquefaction support studies. Task 1: Heat  
of reaction of hydrogen with coal slurries.  
Task 2: Heat transfer coefficient  
[ANL/CEN/FE-77-5] 21 p0216 H79-14242
- MULHEKAR, S. S.  
The Brookhaven buildings energy conservation  
optimization model  
[BBL-50828] 22 p0370 H79-21564
- MULIK, P. R.  
Investigating combustion turbine burner  
performance with coal derived liquids having  
high fuel bound nitrogen  
[ASME PAPER 78-GT-126] 21 p0033 A79-10791
- MULLIGAN, G.  
Development and application of techniques to  
evaluate cogeneration impacts  
22 p0303 A79-29795

MULLIGAN, S. W.

PERSONAL AUTHOR INDEX

- MULLIGAN, S. W.  
Evaluation of dry sorbents and fabric filtration  
for PGD (Flue Gas Desulfurization)  
[PB-289921/9] 22 p0373 N79-21661
- MULLIN, J.  
EPA program conference report: Coal cleaning, an  
option for Increased Coal Utilization  
[PB-288223/1] 22 p0344 N79-17378
- MULLIN, J. P.  
Space power for space 21 p0100 A79-16143  
OAST space power technology program 21 p0169 N79-10123
- MUMMA, S. A.  
The application of ASHRAE Standard 93-77 to the  
thermal performance testing of air solar  
collectors 21 p0102 A79-16423
- MUNJAL, P. K.  
Future solar total energy markets for the U.S.  
industrial sector  
[AIAA PAPER 78-1773] 21 p0062 A79-13870
- MUNOZ, J. T.  
Performance analysis of a flat-plate solar  
collector using 'forge-fin' tubes 22 p0316 A79-31404
- MUNRO, A. H.  
The fleet operator's viewpoint 22 p0302 A79-29495
- MUNRO, N.  
A multivariable controller for an automotive gas  
turbine  
[ASME PAPER 79-GT-73] 22 p0307 A79-30537
- MUNSON, J. S.  
Energy situation in the Mid-Atlantic region  
[BNL-50703] 21 p0188 N79-11528
- MURAKAMI, Y.  
A digital control system for superconducting magnet  
22 p0268 A79-24508
- MURASAKI, H.  
Solar heating performance of the Toshiba Solar  
House No. 1 21 p0137 A79-17465
- MURPHY, B. L.  
Energy consumption of environmental controls -  
Fossil fuel, steam electric generating industry  
21 p0064 A79-14112
- MURPHY, C. L.  
Review of liquid piston pumps and their operation  
with solar energy  
[ASME PAPER 79-SOL-4] 22 p0308 A79-30542
- MURPHY, D. W.  
Low voltage behavior of lithium/metal  
dichalcogenide topochemical cells 22 p0286 A79-26995
- MURPHY, G. W.  
Model systems in photoelectrochemical energy  
conversion 21 p0149 A79-18021
- MURPHY, P.  
The interaction of the wind field with a  
horizontal axis wind turbine 22 p0278 A79-26177
- MURRAY, H. S.  
Solar heating and cooling performance of the Los  
Alamos National Security and Resources Study  
Center 22 p0277 A79-25944
- MURRAY, J. G.  
SLPX - Superconducting Long-Pulse Tokamak Experiment  
22 p0237 A79-20557
- MURRAY, R. G.  
The Koppelman process 21 p0145 A79-17634  
Upgrading lignite by the Koppelman process  
21 p0146 A79-17641
- MURRAY, T. M.  
Analysis of optical behavior and collector  
performance of a solar concentrator 21 p0107 A79-16545
- MURRAY, T. M., JR.  
A microprocessor-based control system for solar  
heating and cooling 21 p0107 A79-16565
- MURTHY, B. S.  
Bio-mass energy for rural areas 21 p0126 A79-17373

- MURTHY, K. S.  
Emissions from pressurized fluidized-bed  
combustion processes 22 p0261 A79-23640
- MUSGROVE, J. G.  
A survey of particulate collection devices for  
coal-fired boilers 21 p0147 A79-17645
- MUSILOVA, N.  
Influence of the electrolyte content of oxygen  
carbon gas-diffusion electrodes on their  
electro-chemical performance in acid solutions  
22 p0245 A79-21483
- MUSINSKI, D. L.  
Point-contact conduction-cooling technique and  
apparatus for cryogenic laser fusion pellets  
21 p0085 A79-15335
- MUSK, E. D.  
The energy dilemma: A challenge for Maryland.  
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Conference  
[PB-284703/6] 21 p0199 N79-12579
- MUSNAHN, G.  
Magnetotelluric and geoelectric measurements for  
geothermal exploration in the Phlegraean Fields  
/preliminary results/ 21 p0075 A79-14732
- MUSSELNAN, H. D.  
Army facility energy conservation 21 p0028 A79-10233
- MUSTAPAEV, A. S.  
Optimization of a Knudsen Cs-Ba thermionic converter  
22 p0241 A79-20940
- MUTDOGAN, A. G.  
Passive solar heating system in Turkey  
22 p0277 A79-25942
- MUTHUVEERAPPAN, V. R.  
Cost effective optimum design of solar air heaters  
21 p0127 A79-17386
- MYERS, D. D.  
The Energy Research and Development Program of the  
United States 22 p0325 A79-31909
- MYERS, I. T.  
Power management and control for space systems  
21 p0170 N79-10134
- MYERS, J. E.  
Alternative central receiver solar power plant  
using salt as a heat transfer and storage medium  
[AIAA PAPER 78-1753] 21 p0060 A79-13855
- MYNETT, J. A.  
Availability of solar energy at Baghdad, Iraq -  
Performance and design data for flat plate  
collectors 21 p0133 A79-17428

N

- NABATOV, G. V.  
Vaporization of drops of a melt of potassium  
carbonate in a medium of combustion products  
21 p0167 A79-20411
- NACK, H.  
Emissions from pressurized fluidized-bed  
combustion processes 22 p0261 A79-23640
- NAEGELI, D. W.  
Effects of fuel properties on soot formation in  
turbine combustion  
[SAE PAPER 781026] 22 p0274 A79-25899
- NAGALINGAM, S. J. S.  
Progress in nuclear-pumped lasers 21 p0110 A79-16627
- NAGDA, N. L.  
Air quality impacts using SRC versus conventional  
coal in power plants  
[PB-290237/7] 22 p0373 N79-21671
- NAGELBERG, A. S.  
Electrochemical determinations of the chemical  
potential and diffusivity of sodium in Na<sub>x</sub>/TaS<sub>2</sub>  
at 300 K 21 p0040 A79-11830
- NAGY, G. D.  
Power supplies for Arctic radio repeater systems  
[AD-A061609] 22 p0339 N79-17118
- NABAS, B. C.  
Catalytic gasification predevelopment research  
21 p0029 A79-10246-

- NAKSMITH, R.  
Passive solar heating and cooling  
[AIAA PAPER 78-1756] 21 p0060 A79-13857
- NAKAGAWA, H.  
General view of low cost solar cell development in Japan 21 p0149 A79-17997
- NAKAO, Y.  
Nuclear characteristics of D-D fusion reactor blankets - Technical data 21 p0162 A79-19826
- NAKASHIMA, H.  
Nuclear characteristics of D-D fusion reactor blankets - Technical data 21 p0162 A79-19826
- NALOS, E. J.  
A microwave power transmission system for space satellite power 21 p0002 A79-10025
- NAKHOONG, D.  
Optimum dry-cooling sub-systems for a solar air conditioner  
[NASA-TS-79007] 21 p0183 A79-11477
- NANDA, S. K.  
Comparative performance of tracking type and non-tracking type solar collectors 21 p0136 A79-17454
- NANIS, L.  
Novel duplex vapor electrochemical method for silicon solar cells  
[NASA-CR-158039] 21 p0218 A79-14537
- NANSEN, R. H.  
Structures for solar power satellites 21 p0032 A79-10513
- NARAYANAN, R.  
The impact of energy resource development on water resource allocations  
[PB-286135/9] 21 p0231 A79-15432
- NARAYANAN, T. V.  
Structural design of a superheater for a central solar receiver  
[ASME PAPER 78-WA/PVP-1] 21 p0162 A79-19832
- NASBY, R. D.  
Development of high-efficiency P(+) - N-N(+) back-surface-field silicon solar cells  
[SAND-78-1156C] 21 p0188 A79-11529
- NASERI, M. A. J.  
Experimental investigation on solar house heating in northern India 21 p0140 A79-17495
- NASH, D. A.  
Coal and nuclear: A comparison of the cost of generating baseload electricity by region  
[PB-289585/2] 22 p0355 A79-19469
- NASH, J. H.  
Modeling, simulation, testing, and measurements for solar energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978 22 p0266 A79-24309
- NATH, P.  
Sprayed CdS thin films for CdS/Cu<sub>2</sub>S heterojunction solar cells 21 p0123 A79-17346  
Stoichiometric Cu<sub>2</sub>S thin films for solar cells 21 p0123 A79-17349
- NATHANS, R.  
Energy needs, uses, and resources in developing countries  
[BNL-50784] 21 p0185 A79-11500
- NATHANSON, D.  
Solar heating and cooling - An electric utility perspective 21 p0093 A79-15890  
A computer simulation model for determining preferred solar heating and cooling systems 22 p0267 A79-24313
- NAWROCKI, P. H.  
Accelerating the commercialization on new technologies  
[ASME PAPER 78-WA/TS-4] 21 p0164 A79-19849
- NAZAROV, A.  
Thermal deformations of solar-energy concentrators 21 p0166 A79-20355
- NECHAY, I. I.  
Properties of the plasma ions and the particle lifetime in ohmic heating in the L-2 stellarator 22 p0244 A79-21428
- NECHAI, V. Z.  
Hybrid reactor based on laser-induced thermonuclear fusion 21 p0032 A79-10658
- NEFF, R. J.  
Gasification of coal with high-temperature reactor heat - Investigations concerning the market and the economics 22 p0264 A79-23828
- NEPEDOV, A. P.  
Plasma diagnostics in an MHD installation 21 p0106 A79-16492
- NEKHAMIN, M. E.  
Stability of combustion in the combustion chamber of an MHD generator 21 p0049 A79-12691
- NELIENSEN, W.  
Hydropower from a national point of view 21 p0059 A79-13656
- NELSON, D. B.  
Macroscopic stability and beta limit in the ELMO Bumpy Torus 22 p0291 A79-27876
- NELSON, J. S.  
Simulations of the performance of open cycle desiccant systems using solar energy 21 p0066 A79-14262
- NELSON, R. H.  
Coal slag effects in MHD generators 21 p0080 A79-14934
- NELSON, W.  
Reservoir ecosystems and western coal development in the upper Missouri River Basin  
[PB-287363/6] 22 p0339 A79-17309
- NEUSTADTER, H. E.  
DOE/NASA Mod-OA wind turbine performance 21 p0028 A79-10235
- NEVEZHIN, O. A.  
Solar-to-thermal energy converter based on coaxial evacuated tubular elements with multilayer and selective coatings 21 p0167 A79-20356
- NEWBY, R. A.  
Circulating-bed boiler concepts for steam and power generation 21 p0008 A79-10071
- NEWMAN, B. G.  
The design and testing of a vertical-axis wind turbine using sails 21 p0153 A79-18467
- NEWMAN, C.  
The production of solar cell grade silicon from bromosilanes  
[NASA-CR-158362] 22 p0358 A79-20482
- NEWTON, A. B.  
Boosting the performance of solar HVAC systems by improving component interactions 21 p0089 A79-15851  
Using controls to reduce component size and energy needs for solar HVAC 21 p0102 A79-16421
- NEYELOFF, S.  
Design of a direct wind energy converter to heat water by agitation in a closed tank 21 p0067 A79-14290
- NG, T. T.  
Ejector augmentation of the air supply in a compressed air energy storage plant 21 p0013 A79-10109
- NGABO, T. H.  
The design and testing of a vertical-axis wind turbine using sails 21 p0153 A79-18467
- NGUYEN, D. G.  
Energy requirements of a limestone PGD system 21 p0114 A79-16747
- NGUYEN, K. H.  
Evaluation of control options for solar climate control systems  
[AIAA PAPER 78-1758] 21 p0060 A79-13859
- NGUYEN, N.  
A study of positive electrode materials for batteries operating in a halide-aluminate medium 22 p0245 A79-21480
- NGUYEN, N. H.  
Copper/water axially-grooved heat pipes for RTG applications 21 p0023 A79-10188

- NIAL, W. R.**  
Laboratory evaluation of a composite flywheel energy storage system  
21 p0013 A79-10110
- NICHOLLS, R. L.**  
Solar radiation charts  
22 p0263 A79-23763
- NICHOLS, D. G.**  
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21 p0063 A79-14106  
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22 p0264 A79-23780  
Pollutants from synthetic fuels production: Facility construction and preliminary tests [PB-287730/6]  
22 p0339 N79-17027
- NICHOLS, G. B.**  
Evaluation of electrostatic precipitator during SRC combustion tests [PB-285864/5]  
21 p0223 N79-14618
- NICOLAOU, M. C.**  
Method of producing a p-type or n-type alloy for direct thermoelectric energy conversion  
22 p0260 A79-23615
- NIEH, S.**  
Thermal analysis of black liquid cylindrical parabolic collector  
22 p0295 A79-28354
- NIELSEN, C. E.**  
Conditions for absolute stability of salt gradient solar ponds  
21 p0133 A79-17431
- NIELSEN, O. M.**  
Effects of minority-carrier storage at the interface states on the fill factor of m.i.s. solar cells  
22 p0313 A79-31347
- NIEHMAN, R. C.**  
A superconducting dipole magnet system for the MHD facility at Univ. of Tennessee Space Institute  
21 p0017 A79-10140  
Cryogenic aspects of the U.S. SCMS superconducting dipole magnet for MHD research  
21 p0084 A79-15303  
Fabrication experiences and operating characteristics of the U.S. SCMS superconducting dipole magnet for MHD research  
21 p0084 A79-15304  
Observation of voltage fluctuations in a Superconducting Magnet during MHD power generation  
22 p0235 A79-20531  
Design and operating experience of the cryogenic system of the U.S. SCMS as incorporated into the bypass loop of the U-25 MHD generator facility  
22 p0235 A79-20532  
A superconducting dipole magnet for the UTSI MHD Facility  
22 p0235 A79-20533  
Superconducting magnet systems for MHD generator facilities  
22 p0290 A79-27662
- NIEHCZYK, T. M.**  
Underground coal gasification research at the University of New Mexico  
21 p0032 A79-10523
- NIEMEYER, W.**  
Santa Clara Community Center Project, USA  
22 p0277 A79-25945
- NIESSEN, H. F.**  
The potential of fusion reactors as process heat source  
22 p0284 A79-26624
- NIESSEN, P.**  
Optimization studies on black chrome electroplating variables for solar selective surfaces  
22 p0317 A79-31407
- NIESSING, W. J.**  
Plan for the development and implementation of standards for solar heating and cooling applications [PB-283237/6]  
21 p0190 N79-11543  
Laboratories technically qualified to test solar collectors in accordance with ASHRAE standard 93-77: A summary report [PB-289729/6]  
22 p0363 N79-20524
- NIGAGUNA, B. T.**  
Optimum tube pitch in solar collectors  
21 p0132 A79-17421
- NIGRO, D. M.**  
Field experience with the Detroit Diesel Allison 404/505 industrial gas turbine engines [SAE PAPER 790129]  
22 p0314 A79-31361
- NIHBI, H.**  
200-kv Blumlein transmission line for ultrafast toroidal theta-pinch  
22 p0297 A79-28917
- NIKLAJSSON, G. A.**  
Selective absorption of solar energy by ultrafine metal particles  
21 p0127 A79-17382
- NIKOLOV, I.**  
Influence of composition on the activity of tungsten carbide gas diffusion hydrogen electrodes  
22 p0245 A79-21482
- NIKURV, I. A.**  
'Local' breakdown criterion in highly ionized gas flow  
21 p0049 A79-12683
- NILSSON, T.**  
Utility fuel cells for biomass fuel  
21 p0016 A79-10131
- NINHO, B.**  
An analytical and experimental study of pumped solar water heaters  
21 p0128 A79-17389
- NINHO, E. H.**  
International project catalog of modular integrated utility systems [PB-283477/8]  
21 p0190 N79-11544  
Committee on the Challenges of Modern Society Rational use of Energy Pilot Study Modular Integrated Utility Systems Project. Volume 1: Description, activities, and products [PB-283428/1]  
21 p0190 N79-11549  
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21 p0191 N79-11558
- NISHIDA, H.**  
Charge transfer by surface states in the photoelectrolysis of water using a semiconductor electrode  
22 p0254 A79-22320
- NISHIKAWA, H.**  
A new combustion system in the three-valve stratified charge engine [SAE PAPER 790439]  
22 p0316 A79-31376
- NISHIMURA, H.**  
A digital control system for superconducting magnet  
22 p0268 A79-24508
- NISSEN, H.-H.**  
The economics of electric power generation from wind energy  
22 p0310 A79-30998
- NIX, C. E.**  
Energy-related pollutants in the environment: The use of short-term for mutagenicity in the isolation and identification of biohazards [CONF-780121-2]  
21 p0192 N79-11568
- NIXON, J. H.**  
HYCSOS - A system for evaluation of hydrides as chemical heat pumps  
22 p0252 A79-21716
- NOE, M. D.**  
Particulate control for coal-fired industrial boilers  
21 p0065 A79-14123
- NOGGLE, L. W.**  
The potential of liquid hydrogen as a military aircraft fuel  
22 p0238 A79-20773  
Large-vehicle concepts  
22 p0306 A79-30485
- NOGUCHI, T.**  
The testing procedures of thermal performance of solar collector at Solar Research Lab., G.I.E.I.  
21 p0130 A79-17409
- NOLL, S.**  
Impacts of the National Energy Plan on solar economics [CONF-771203-6]  
21 p0118 A79-17294

- NOLL, S. A.  
The economic performance of passive solar heating  
- A preliminary analysis  
[AIAA PAPER 78-1761] 21 p0061 A79-13862
- NONGBHI, G.  
Demetallization catalyst tests on heavy residual  
oils  
[PB-285937/9] 21 p0232 A79-15864
- NOON, E. L.  
Analytical predictions of selenide RTG power  
degradation 21 p0026 A79-10223
- NORRIS, D. L.  
Fuel conservative aircraft engine technology 21 p0164 A79-20078
- NORGATE, G.  
The first year of solar collector testing at  
Ontario Research 22 p0322 A79-31450
- NORMAN, J. H.  
Engineering and bench-scale studies of the  
sulfur-iodine cycle at General Atomic 21 p0015 A79-10127
- NORMAN, R. H.  
Cooling radioisotope thermoelectric generators in  
the Shuttle 21 p0023 A79-10186
- NORTHRUP, D. A.  
Instrumentation development for in situ coal  
gasification 21 p0006 A79-10053  
Instrumentation for in situ coal gasification. II  
- Thermal and gas sampling diagnostic techniques 21 p0032 A79-10520  
Instrumentation for in situ coal gasification. IV  
- Seismic and acoustic techniques for remote  
monitoring 22 p0304 A79-29974
- NORTHRUP, C. J. H.  
Acoustic emissions during hydride formation 22 p0249 A79-21691
- NOSEK, S. H.  
Ceramics for the advanced automotive gas turbine  
engine - A look at a single shaft design 21 p0050 A79-12850
- NOVAK, H.  
USAF terrestrial energy study. Volume 3, part 1:  
Summary data display  
[AD-A061071] 22 p0342 A79-17341
- NOVAK, R. J.  
Recent advances in convectively cooled engine and  
airframe structures for hypersonic flight 21 p0165 A79-20087
- NUMZIATA, C.  
Shallow magmatic reservoirs as heat source of  
geothermal systems - Preliminary interpretation  
of data available for the Neapolitan active  
volcanic areas 21 p0075 A79-14727
- NUSKE, D. J.  
A multivariable controller for an automotive gas  
turbine  
[ASME PAPER 79-GT-73] 22 p0307 A79-30537
- NUSSBERGER, A. A.  
The design and evaluation of a 5 GW Gallia solar  
power satellite /SPS/ 21 p0002 A79-10024
- NUTTALL, H. E.  
Underground coal gasification research at the  
University of New Mexico 21 p0032 A79-10523
- NUTTALL, L. J.  
Progress in solid polymer electrolyte water  
electrolysis 22 p0289 A79-27653
- OBERG, C. L.  
Coal conversion by flash hydrolysis and  
hydrogasification 21 p0006 A79-10055
- OBERJOHN, W. J.  
Performance of a 5 MWT solar steam generator 22 p0288 A79-27399
- OBERLY, C. E.  
Air Force applications of lightweight  
superconducting machinery 22 p0290 A79-27666
- OBENHAN, C.  
Theory of dissipative drift instabilities in  
sheared magnetic fields 22 p0292 A79-27884
- OBRIEN, P. J.  
Simulation study of the effect of  
fuel-conservative approaches on ATC procedures  
and terminal area capacity  
[SAE PAPER 780523] 21 p0031 A79-10398  
Dynamic simulation studies of fuel conservation  
procedures used in terminal areas 22 p0259 A79-23581
- ODONNELL, P.  
NASA Lewis Research Center photovoltaic  
application experiments  
[AIAA PAPER 78-1768] 21 p0061 A79-13867
- OPARRELL, R. W.  
Solar cell module assembly jig  
[NASA-CASE-IGS-00829-1] 22 p0353 A79-19447
- OPARRELL, P. H.  
A computer simulation model for determining  
preferred solar heating and cooling systems 22 p0267 A79-24313
- OFFENHARTZ, P. O'D.  
Chemically driven heat pumps for solar thermal  
storage 21 p0120 A79-17316
- OPFERHOLZ, E.  
Passive solar house in Vetlanda - Interim report 22 p0277 A79-25943
- OGALLAGHER, J.  
Compound parabolic concentrators with  
non-evacuated receivers - Prototype performance  
and a larger scale demonstration in a school  
heating system 21 p0134 A79-17440  
High temperature solar collector of optimal  
concentration - Non-focusing lens with secondary  
concentrator 21 p0135 A79-17448
- OGALLAGHER, J. J.  
A compound parabolic concentrator for a high  
temperature solar collector requiring only  
twelve tilt adjustments per year 21 p0134 A79-17439
- OHLIG, U.  
The potential of fusion reactors as process heat  
source 22 p0284 A79-26624
- OHNO, T.  
Engineering and bench-scale studies of the  
sulfur-iodine cycle at General Atomic 21 p0015 A79-10127
- OHYA, H.  
Nuclear characteristics of D-D fusion reactor  
blankets - Technical data 21 p0162 A79-19826
- OKABAYASHI, H.  
SLPX - Superconducting Long-Pulse Tokamak Experiment 22 p0237 A79-20557
- OKUDA, H.  
The utilization of LH2 and LNG cold for generation  
of electric power by a cryogenic-type Stirling  
engine 22 p0311 A79-31020
- OLDHAM, L. P.  
Five MW solar thermal test facility heliostat  
focus and alignment system 21 p0043 A79-11972
- OLEISEY, R. A.  
Evaluation of the Ames, Iowa refuse derived fuel  
recovery system 21 p0064 A79-14115  
Corrosion and deposits from combustion of solid  
waste. VI - Processed refuse as a supplementary  
fuel in a stoker-fired boiler  
[ASME PAPER 78-WA/PU-4] 21 p0160 A79-19788
- OLSEN, L. J.  
Electrochemical characteristics of ZrO2-Y2O3 solid  
electrolytes for fuel cells 21 p0039 A79-11813
- OLSEN, A. R.  
Stored energy calculation: The state of the art  
[PRL-2581] 21 p0210 A79-13541
- OLSEN, L. C.  
Explanation for low-efficiency Cu2O  
Schottky-barrier solar cells 22 p0256 A79-22859



- OLSEN, H. H.  
Potential producibility and recovery of natural gas from geopressured aquifers of the Cenozoic sediments of the Gulf Coast Basin  
[FE-2025-3] 21 p0192 N79-11607
- OHAN, B. H.  
Vehicle Design Evaluation Program (VEEP). A computer program for weight sizing, economic, performance and mission analysis of fuel-conservative aircraft, multibodied aircraft and large cargo aircraft using both JP and alternative fuels  
[NASA-CR-145070] 21 p0200 N79-13026
- OHAN, H.  
Electrical power loss from high-voltage power circuits through plasma leakage 21 p0169 N79-10113
- OHAN, R. A.  
Fluid dynamics of diffuser-augmented wind turbines 22 p0238 A79-20798
- OHOLT, T.  
A wave activated electric generator 22 p0288 A79-27389
- OHURTAG, Y.  
A survey of energy information systems and its implications for industrial energy management 21 p0072 A79-14685
- ONDÖV, J. H.  
Chemical studies of stack fly ash from a coal-fired power plant 22 p0309 A79-30595
- ONEILL, P.  
The dependence of optical properties on the structural composition of solar absorbers - Gold black 22 p0242 A79-21162  
Microstructure dependence of the optical properties of solar-absorbing black chrome 22 p0256 A79-22858
- ONG, K. S.  
Comparative performance testing of flat-plate solar water heaters 21 p0130 A79-17405
- ONG, T. H.  
Simulation study of phase change energy store 21 p0120 A79-17318
- ONOFREICZUK, S.  
The application of hydraulics in the 2,000 kW wind turbine generator 22 p0288 A79-27400
- OOI, B. T.  
Induction-generator/synchronous-condenser system for wind-turbine power 22 p0286 A79-27219
- ORBACH, A.  
Optimizing solar energy systems using continuous flow control 21 p0138 A79-17477
- ORGAN, A. J.  
Mechanical efficiency of the Stirling cycle machine with rhombic drive 21 p0025 A79-10208
- ORGILL, J. F.  
Component cost of solar energy systems 22 p0319 A79-31429  
WATSUN - A simulation program for solar-assisted heating systems 22 p0321 A79-31439
- ORGILL, H. H.  
Siting handbook for small wind energy conversion systems [PNL-2521] 21 p0209 N79-13527
- ORLANDO, A. F.  
Thermosyphon solar water heating system under Brazilian conditions 21 p0021 A79-10177
- ORLOSKEI, H. J.  
State-of-the-art study of heat exchangers used with solar assisted domestic hot water systems (potential contamination of potable water supply) [PB-287410/5] 22 p0343 N79-17351
- ORSINI, R. A.  
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- ORTEGA, A.  
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- OSBORN, D. E.  
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- OSHIMA, K.  
The utilization of LH2 and LNG cold for generation of electric power by a cryogenic-type Stirling engine 22 p0311 A79-31020
- OSTASHOV, V. H.  
Dependence of the pour point of diesel fuels on the properties of the initial components [NASA-TN-75424] 22 p0364 N79-21217
- OTHERER, P. W.  
The El Camino Real Solar Cooling Demonstration Project 21 p0102 A79-16425
- OTIS, D. B.  
Ejector augmentation of the air supply in a compressed air energy storage plant 21 p0013 A79-10109
- OTT, E.  
Wave reflection from the lower hybrid surface - A toroidal effect 22 p0255 A79-22427
- OTTINGER, P. P.  
Microstability of a focused ion beam propagating through a z-pinch plasma 22 p0270 A79-24817
- OTTS, J. V.  
The USA 5MW solar thermal test facility 21 p0135 A79-17449  
Solar thermal test facility experiment manual [SAND-77-1173] 21 p0221 N79-14568
- OUCHI, K.  
Reaction mechanism of alkali-alcohol treatment of coal 22 p0299 A79-29315
- OUTULNY, K.  
The optimum voltage for batteries used in standby lighting systems [BLL-RTS-11512] 22 p0347 N79-18439
- OVCHARENKO, V. A.  
Commercial realization of MHD - A challenge for superconducting magnets 21 p0084 A79-15302
- OVERSKET, D.  
The effects of wall temperature on light impurities in Alcator 22 p0313 A79-31188
- OVEZSAKHATOV, H.  
Determination of thermal contact resistances 21 p0166 A79-20351
- OVEZSAKHATOV, H. O.  
The attainable efficiency of the solar thermoelectric generators 21 p0140 A79-17496
- OVSHINSKY, S. R.  
A new amorphous silicon-based alloy for electronic applications 21 p0100 A79-16226
- OWEN, P. T.  
An inventory of environmental impact models related to energy technologies [ORNL/EIS-147] 22 p0372 N79-21640
- OWENS, R. E.  
Energy efficient engine: Propulsion system-aircraft integration evaluation [NASA-CR-159488] 22 p0337 N79-16850
- OWENS, W. H.  
Preliminary summary of the ETP conceptual studies [NASA-TN-78999] 21 p0183 N79-11478
- OXLEY, J. H.  
A summary of R&D programs 21 p0146 A79-17639  
EPA program conference report: Coal cleaning, an option for Increased Coal Utilization [PB-288223/1] 22 p0344 N79-17378
- OZEROFF, H. J.  
Satellite Power System (SPS) military applications [NASA-CR-158109] 22 p0337 N79-16895
- PADEN, L. J.  
Temperature dependent parameter analysis of thermoelectric devices 21 p0113 A79-16740

- PADERIN, L. IA.**  
Effect of form errors on the characteristics of ellipsoidal radiant energy concentrators  
22 p0296 A79-28667
- PADUNCHAI, S.**  
The impact of energy resource development on water resource allocations  
[PB-286135/9] 21 p0231 N79-15432
- PAGE, D. J.**  
Phase two of the array automated assembly task for the low cost solar array project  
[NASA-CR-158359] 22 p0359 N79-20484
- PAGE, G. C.**  
Guidelines for preparing environmental test plans for coal gasification plants  
[PB-286659/8] 21 p0232 N79-15479  
Environmental assessment: Source test and evaluation report, Chapman low-Btu gasification  
[PB-289940/9] 22 p0373 N79-21662
- PAHOJA, E. H.**  
Comparative performance of tracking type and non-tracking type solar collectors  
21 p0136 A79-17454
- PAI, V. P.**  
Energy availabilities for state and local development: 1973 data volume  
[ORNL/TM-5890-S2] 21 p0175 N79-10541  
Energy availabilities for state and local development: 1974 data volume  
[ORNL/TM-5890-S3] 21 p0175 N79-10542  
Energy availabilities for state and local development: Projected energy patterns for 1980 and 1985  
[ORNL/TM-5890/54] 21 p0186 N79-11511
- PAL, B. P.**  
Performance of solar concentrators - A theoretical study  
21 p0135 A79-17453
- PAL, D.**  
Field testing of 5-kW commercial wind generator with an automatic load-matching device for utilizing its output  
21 p0143 A79-17515  
A technique for longitudinal correlation of wind data - Theory and its application to siting of wind power plants  
21 p0143 A79-17518
- PALEN, W. A.**  
A computerized reporting and monitoring system for geothermal energy development  
[LBL-8483] 22 p0369 N79-21555
- PALMEDO, P. P.**  
Energy needs, uses, and resources in developing countries  
[BNL-50784] 21 p0185 N79-11500
- PALMER, A. J.**  
Radiatively sustained cesium plasmas for solar electric conversion  
21 p0109 A79-16615
- PALMER, E. A.**  
Simulation study of the effect of fuel-conservative approaches on ATC procedures and terminal area capacity  
[SAE PAPER 780523] 21 p0031 A79-10398  
Dynamic simulation studies of fuel conservation procedures used in terminal areas  
22 p0259 A79-23581
- PALMER, G. E.**  
Hybrid air to water solar collector design  
21 p0021 A79-10174
- PALMER, J. D.**  
An assessment of thermal energy storage and waste heat dissipation with total energy systems for MIT  
[AD-A059061] 21 p0205 N79-13502
- PALESTER, L.**  
Measured and modeled passive performance in Montana  
22 p0322 A79-31445
- PALOWITCH, E. B.**  
An approach to automated longwall mining  
[AIAA PAPER 79-0532] 22 p0274 A79-25871
- PAW, S. S.**  
A one-dimensional combustion model for a dual chamber stratified charge spark ignition engine  
[SAE PAPER 790355] 22 p0315 A79-31371
- PANDE, G. D.**  
A report on the various heat collection and heat storage systems evolved under the solar energy programme at B. I. T. S.  
21 p0132 A79-17423
- PANDE, K. P.**  
Grain-boundary edge passivation of GaAs films by selective anodization  
21 p0154 A79-18487
- PANDYA, D. K.**  
Transparent conducting coatings for solar cells  
21 p0124 A79-17350  
Selective coatings for solar energy conversion  
21 p0126 A79-17376
- PANERO, S.**  
On the possibility of using silver salts other than Ag<sub>2</sub>CrO<sub>4</sub> in organic lithium cells  
22 p0246 A79-27491
- PANGBORN, J. B.**  
New energy from an old source - Hydrogen from falling water  
21 p0015 A79-10129  
Hydrogen via thermochemistry and future water-splitting technologies  
22 p0289 A79-27654
- PANICHI, C.**  
Suggestions for a geochemical prospecting of geothermal systems - A first survey of the Italian thermal springs  
21 p0075 A79-14737
- PANNO, G.**  
The relationship between diffuse and total solar radiation in computer simulation of solar energy systems  
21 p0119 A79-17304
- PANOV, D. A.**  
Cryogenic technology and superconductivity in controlled fusion  
22 p0311 A79-31003
- PANYAKEOW, S.**  
Ga<sub>1-x</sub>Al<sub>x</sub>As-GaAs photovoltaic cells with multilayer structure  
22 p0305 A79-30258
- PAPADOPOULOS, K.**  
Electrons of high perpendicular energy in the low-density regime of tokamaks  
22 p0270 A79-24852
- PAPINI, P.**  
Effect of physical properties of a flat plate solar collector cover on efficiency calculations - Simplifying hypotheses  
21 p0164 A79-19849
- PAPUSHA, O. E.**  
Spatial oscillations of a solid body carrying a low-power flywheel motor  
21 p0148 A79-17792
- PAQUETTE, E. L.**  
Preliminary analysis of advanced ceramic magnetohydrodynamic /MHD/ combustor design concepts  
22 p0240 A79-20838
- PARAIN, J.**  
Conceptual design of a superconducting tokamak - 'TORUS II SUPRA'  
22 p0236 A79-20543
- PARANJPE, P. A.**  
Cycle optimization for a solar turbopack  
21 p0141 A79-17500  
Application of turbopack in solar energy systems  
21 p0141 A79-17504
- PARASCHIVOIU, I.**  
A hybrid wind turbine suitable for developing regions  
22 p0323 A79-31455
- PARFENOV, O. G.**  
Fast penetration of a magnetic field into a low-density plasma  
22 p0244 A79-21432
- PARIKH, P. P.**  
Design and optimization of a flat plate collector for cooling application  
21 p0132 A79-17419
- PARK, G. L.**  
An analytical expression for the specific output of wind turbine generators  
22 p0273 A79-25720
- PARKER, A. J., JR.**  
The status of alcohol fuels utilization technology for highway transportation  
21 p0003 A79-10035  
Principles of solar cooling and heating  
21 p0103 A79-16457

- Application of solar cooling for a school building in subtropics  
21 p0103 A79-16461
- PARKER, C. E.  
A technique for longitudinal correlation of wind data - Theory and its application to siting of wind power plants  
21 p0143 A79-17518
- PARKER, C. L.  
Environmental assessment data base for coal liquefaction technology. Volume 2: Synthoil, H-coal, and Exxon donor solvent processes [PB-287800/7]  
22 p0344 A79-17365
- PARKER, J. C.  
Development, testing, and certification of Calmac Mfg. Corp. solar collector and solar operated pump [NASA-TM-78218]  
22 p0342 A79-17338  
Development, testing, and certification of the Northrup, Inc., M1 series concentrating solar collector model NSC-01-0732 [NASA-TM-78219]  
22 p0371 A79-21618  
Development, testing, and certification of Owens-Illinois model SEC-601 solar energy collector system [NASA-TM-78223]  
22 p0371 A79-21620
- PARKER, S. A.  
Power generation using thermal vapor pumping and hydro-pumped storage - Thermal gradient utilization cycle /TGUC/  
21 p0095 A79-15914  
Thermal gradient-hydro generation cycle /TGUC/  
21 p0098 A79-16102
- PARKS, G. E.  
Shock-tube measurements of induction and post-induction rates for low-Btu gas mixtures  
21 p0083 A79-15245
- PARKS, P. C.  
A wave power machine using free floating vertical plates  
21 p0151 A79-18104
- PARROTT, J. E.  
Theoretical upper limit to the conversion efficiency of solar energy  
21 p0042 A79-11876  
The limiting efficiency of an edge-illuminated multigap solar cell  
22 p0305 A79-30259
- PARSONS, B. I.  
Coke formation on hydrodesulphurization catalysts  
22 p0283 A79-26470
- PARSONS, R. E.  
Design guide for shallow solar ponds [UCRL-52385]  
21 p0185 A79-11497
- PARTI, R.  
Power from glaciers - The hydropower potential of Greenland's glacial water  
21 p0087 A79-15672
- PASHEV, S. A.  
U-25B MHD unit for carrying out investigations under the conditions of strong electric and magnetic fields  
21 p0049 A79-12692  
Channel No. 1 of the MHD generator of a U-25B unit for carrying out investigations in strong electric and magnetic fields  
21 p0049 A79-12693
- PASQUALETTI, M. J.  
Geothermal energy in Imperial County, California - Environmental, socio-economic, demographic, and public opinion research conclusions and policy recommendations  
22 p0265 A79-24046
- PASQUETTI, R.  
Solar thermal conversion installations in the medium power range - The Thex project  
22 p0254 A79-22269
- PATAKAB, S. V.  
Heat transfer - A review of 1977 literature  
21 p0155 A79-18973
- PATEL, A. S.  
Study of integrated gasification combined cycle plant interaction and control [ASME PAPER 79-GT-60]  
22 p0306 A79-30530
- PATEL, D.  
Heat transfer in phosphoric acid fuel cell stacks  
21 p0010 A79-10091
- PATEL, J. S.  
A report on the various heat collection and heat storage systems evolved under the solar energy programme at B. I. T. S.  
21 p0132 A79-17423
- PATEL, S. S.  
Environmental assessment data base for coal liquefaction technology. Volume 1: Systems for 14 liquefaction processes [PB-287799/1]  
22 p0344 A79-17364
- PATIENCE, R. L.  
The effect of maturation on the configuration of pristane in sediments and petroleum  
22 p0272 A79-25375
- PATIL, P. G.  
Thermal performance of solar collectors used in the national solar heating and cooling demonstration program  
21 p0130 A79-17403
- PATTERSON, S. V.  
Wind power site evaluation. I - Wind energy potential. II - Data acquisition and processing  
22 p0257 A79-22924
- PATTEN, J.  
Technical support for open-cycle MHD program [ANL-MHD-78-8]  
22 p0361 A79-20507
- PATTERSON, P. D.  
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21 p0184 A79-11487
- PATTERSON, R. D.  
Production and use of low and medium Btu gas  
21 p0095 A79-15912
- PATTON, B. G.  
Techniques for preventing damage to high power laser components  
21 p0083 A79-15145
- PAUL, D. K.  
Characterisation of amorphous semiconductor materials for solar cell applications  
21 p0123 A79-17341
- PAUL, J. K.  
Passive solar energy design and materials  
22 p0302 A79-29625
- PAUL, J. W. H.  
Review of results from DITE tokamak  
21 p0069 A79-14456
- PAUVER, W. P.  
Flow modeling of an atmospheric pressure, entrained-type coal gasifier  
22 p0280 A79-26188
- PAVLIUK, V. A.  
Superconductivity in antenna engineering  
22 p0311 A79-31008
- PAYNE, P. B.  
The fossil fuel cost of solar heating  
21 p0022 A79-10180
- PAYTON, B. A.  
A microprocessor-based control system for solar heating and cooling  
21 p0107 A79-16565
- PEACOCK, M. J.  
Review of results from DITE tokamak  
21 p0069 A79-14456
- PEARCE, J.  
An analytical and experimental study of pumped solar water heaters  
21 p0128 A79-17389
- PEARSON, C. V.  
Preliminary summary of the ETP conceptual studies [NASA-TM-78999]  
21 p0183 A79-11478
- PEARSON, D.  
A test bed for thermosyphon solar air collectors [AIAA PAPER 79-0541]  
22 p0274 A79-25860
- PEARSON, G. F.  
A lithium/dissolved sulfur battery with an organic electrolyte  
22 p0305 A79-30332
- PEARSON, R. G.  
Energy analysis [NP-23145]  
21 p0187 A79-11513
- PECK, J. F.  
The ClearView Solar Collector system and associated one and two stage evaporative cooling - Interim results [AIAA PAPER 78-1759]  
21 p0061 A79-13860
- PEDERSEN, B.  
Nuclear magnetic resonance studies of metal hydrides  
22 p0248 A79-21683

- PEEBLES, P. Z., JR.  
Accuracy analysis of pointing control system of solar power station  
[NASA-CR-150880] 21 p0215 N79-14143
- PEJSA, J. H.  
Evaluation of control options for solar climate control systems  
[AIAA PAPER 78-1758] 21 p0060 A79-13859  
Jet impingement solar air heater  
[AIAA PAPER 78-1760] 21 p0061 A79-13861
- PELCZARSKI, W.  
A superconducting dipole magnet for the UTSI MHD Facility  
22 p0235 A79-20533
- PELCZARSKI, W. J.  
Cryogenic aspects of the U.S. SCMS superconducting dipole magnet for MHD research  
21 p0084 A79-15303  
Fabrication experiences and operating characteristics of the U.S. SCMS superconducting dipole magnet for MHD research  
21 p0084 A79-15304
- PELTO, C. B.  
Energy information: Report to Congress  
[NTISUB/C/027-001] 21 p0221 N79-14576
- PELTZMAN, E. S.  
Controls for residential solar heating  
21 p0101 A79-16418
- PENN, L. S.  
Comparative properties of fiber composites for energy-storage flywheels part A. Evaluation of fibers for flywheel rotors  
[UCRL-80116-PT-A] 21 p0215 N79-14165
- PENNEL, W. T.  
Wind characteristics program element  
[PWL-2545] 22 p0356 N79-19568
- PENNER, B. S.  
Total energy and labor requirements for an electric commuter railroad  
21 p0068 A79-14325
- PENNER, S. S.  
Shock-tube measurements of induction and post-induction rates for low-Btu gas mixtures  
21 p0083 A79-15245  
The AGARD propulsion and energetics panel, 1952-1977  
[AGARD-AR-111] 22 p0337 N79-16848
- PERALDO, H.  
Selective covers for natural cooling devices  
22 p0272 A79-25522
- PERALTA BELLIDO, H.  
Study of the characteristics of Ni-Cd storage batteries for space applications  
22 p0304 A79-30207
- PERCHERON-GUEGAN, A.  
Hydrogen electrochemical storage by substituted LaNi5 compounds  
22 p0251 A79-21711
- PERCIVAL, W. H.  
Potential of the Stirling engine for stationary power applications in the 500-2000 HP range  
21 p0025 A79-10211
- PERGAMENT, V. I.  
Effect of the magnetic configuration of the poloidal diverter on the plasma in the T-12 finger-ring tokamak  
22 p0244 A79-21429
- PERI, G.  
Solar thermal conversion installations in the medium power range - The Thek project  
22 p0254 A79-22269
- PERINO, A. H.  
Solar powered irrigation: Present status and future outlook  
[SAND-78-0016C] 21 p0175 N79-10539  
Preliminary economic analysis of Solar Irrigation Systems (SIS) for selected locations  
[SAND-77-1403] 21 p0220 N79-14566
- PERKINS, G. S.  
A low cost high temperature sun tracking solar energy collector  
22 p0366 N79-21390
- PERKINS, S. P., JR.  
Assessment of the potential of solar thermal small power systems in small utilities  
[NASA-CR-158093] 22 p0335 N79-16377
- PERRY, A. H.  
Net energy analysis of five energy systems  
[ORAU/IEA(B)-77-12] 21 p0174 N79-10534
- PERRY, J.  
Improved anodes for liquid hydrocarbon fuel cell  
[AD-A058456] 21 p0206 N79-13504
- PERRY, R. T.  
Perspective on the fusion-fission energy concept  
21 p0095 A79-15913
- PERSHING, D. W.  
Combustion modification pollutant control techniques for industrial boilers - The influence of fuel oil properties and atomization parameters  
[ASME PAPER 78-WA/APC-13] 21 p0159 A79-19742
- PESCHEL, W. B.  
Development of ceramic parts for a truck gas turbine at MTU  
21 p0050 A79-12831
- PESCHKA, W.  
Space power technology - Current status and future development trends  
[DGLR PAPER 78-167] 21 p0063 A79-14054
- PESCHIN, V. R.  
Combustion of porous particles  
21 p0049 A79-12708
- PETERMAN, D. D.  
Energy distribution and storage alternates with a centralized heat source  
21 p0013 A79-10112
- PETERS, B. C.  
Chemicals from coal. Report based on HRI B-coal product  
[PE-1534-50] 21 p0180 N79-11166
- PETERS, D. A.  
Lag damping in autorotation by a perturbation method  
[AHS 78-25] 21 p0152 A79-18151
- PETERS, J. E.  
Ignition/stabilization/atomization - Alternative fuels in gas turbine combustors  
21 p0052 A79-12982
- PETERSEN, C. K.  
Design studies and trade-off analyses for a superconducting magnet/MHD power generator system  
21 p0017 A79-10142  
Corrosion and deposits in MHD generator systems  
21 p0081 A79-14935
- PETERSON, D. J.  
Applications of thermal energy storage to process heat and waste heat recovery in the iron and steel industry  
[NASA-CR-159397] 21 p0183 N79-11473
- PETERSON, R. A.  
Biomass utilization in Minnesota  
[PB-282531/3] 21 p0171 N79-10241
- PETIT, R. B.  
Effect of surface curvature on measurement of the absorptance properties of solar coatings  
21 p0042 A79-11879
- PETRICK, H.  
Open-cycle magnetohydrodynamic electrical power generation  
21 p0104 A79-16478  
The MHD power plant and its environmental aspects - Introduction  
21 p0105 A79-16479  
Technical and economic aspects of open-cycle MHD power plants  
21 p0105 A79-16482  
Experimental two-phase liquid-metal magnetohydrodynamic generator program  
[AD-A059240] 21 p0197 N79-12564  
MHD balance of plant technology project  
[ANL-MHD-78-7] 22 p0361 N79-20500
- PETROV, V. G.  
Heat transport near the wall of a tokamak reactor  
22 p0324 A79-31764
- PETROVA, L. I.  
Study of diffusion processes in low-temperature thermopiles  
21 p0054 A79-13290
- PETROVICH, A.  
Conductor for LASL 10-MW hr superconducting energy storage coil  
21 p0085 A79-15309
- PETTIT, R. B.  
Optical evaluation techniques for reflecting solar concentrators  
21 p0043 A79-11971
- PETTITT, R. A.  
Hot dry rock - A new potential for energy  
22 p0265 A79-23832

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- PFILIPPER, W.  
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ohmically-heated tokamaks 22 p0253 A79-22240
- PFENDER, E.  
Heat transfer - A review of 1977 literature 21 p0155 A79-18973
- PFIRSCH, D.  
MHD equilibrium and stability 21 p0078 A79-14779
- Collisional transport 21 p0078 A79-14780
- Equilibrium relations in the presence of arbitrary  
plasma diffusion in axisymmetric configurations 22 p0257 A79-22979
- Collisional transport 22 p0257 A79-22980
- PFISTERER, F.  
Improvement of efficiency and stability by  
copper-treatment and front contacting of  
Cu/x/S-CdS solar cells 21 p0123 A79-17345
- A pilot line for the production of large area  
Cu/x/S-CdS solar cells 21 p0124 A79-17351
- PHARABOD, F.  
Production of mechanical energy by thermodynamic  
conversion of solar energy 22 p0310 A79-30999
- PHELINE, B. J.  
Report on the development of solar energy in France 21 p0117 A79-17280
- PHILIP, C. V.  
Synthetic fuels from Gulf Coast lignite 21 p0146 A79-17643
- PHILLIPS, C. W.  
International project catalog of modular  
integrated utility systems 21 p0190 N79-11544
- [PB-283477/8] 21 p0190 N79-11544
- Committee on the Challenges of Modern Society  
Rational use of Energy Pilot Study Modular  
Integrated Utility Systems Project. Volume 1:  
Description, activities, and products 21 p0190 N79-11549
- [PB-283428/1] 21 p0190 N79-11549
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rational use of energy pilot study modular  
integrated utility system project. Volume 2:  
Minutes of project meeting 21 p0191 N79-11558
- [PB-283429/9] 21 p0191 N79-11558
- PHILLIPS, P. H.  
Energy scenarios: Supplementary studies 21 p0211 N79-13543
- [NP-23292] 21 p0211 N79-13543
- PHILLIPS, R. C.  
The Koppelman process 21 p0145 A79-17634
- Upgrading lignite by the Koppelman process 21 p0146 A79-17641
- PHILLIPS, S. L.  
National Geothermal Information Resource 21 p0187 N79-11515
- [LBL-7803] 21 p0187 N79-11515
- A computerized reporting and monitoring system for  
geothermal energy development 22 p0369 N79-21555
- [LBL-8483] 22 p0369 N79-21555
- PHILP, R. P.  
Organic geochemical studies on kerogen precursors  
in recently deposited algal mats and cozes 21 p0031 A79-10419
- PHUNG, D. L.  
Three modes of energy cost analysis: Then-current  
dollars, base-year dollars, and  
perpetual-constant dollars 21 p0209 N79-13531
- [ORAU/IEA(M)-78-10] 21 p0209 N79-13531
- PIAN, C. C. P.  
Velocity, temperature, and electrical conductivity  
profiles in hydrogen-oxygen MHD duct flows 22 p0279 A79-26184
- Evaluation of the ECAS open cycle MHD power plant  
design 22 p0341 N79-17335
- [NASA-TN-79012] 22 p0341 N79-17335
- PICCOLO, R.  
Fiat Research Center hybrid vehicle prototype 22 p0313 A79-31351
- [SAE PAPER 790014] 22 p0313 A79-31351
- PICK, J. B.  
Geothermal energy in Imperial County, California -  
Environmental, socio-economic, demographic, and  
public opinion research conclusions and policy  
recommendations 22 p0265 A79-24046
- PIELERT, J. B.  
Plan for the development and implementation of  
standards for solar heating and cooling  
applications 21 p0190 N79-11543
- [PB-283237/6] 21 p0190 N79-11543
- PIERCE, W. T.  
The Alcator liquid nitrogen-cooled tokamaks 22 p0290 A79-27668
- PIERONI, C. A.  
Power cables to accommodate the motions of an OTEC  
plant 21 p0101 A79-16251
- PIERRE, D. A.  
Reducing combustion air temperature variations in  
magnetohydrodynamic/steam power plants 21 p0016 A79-10135
- Magnetohydrodynamic/steam power plant modeling and  
control 21 p0046 A79-12274
- PIERSON, E. S.  
Experimental two-phase liquid-metal  
magnetohydrodynamic generator program 21 p0197 N79-12564
- [AD-A059240] 21 p0197 N79-12564
- PIETHUSZKIEWICZ, J.  
Optimum design conditions for a power plant at a  
vapor dominated geothermal resource, Pacific Gas  
and Electric's The Geysers Power Plant Unit 16 21 p0014 A79-10121
- History and development of condensers at the  
Geysers geothermal power plant 21 p0150 A79-18099
- [ASME PAPER 78-JPGC-PWR-18] 21 p0150 A79-18099
- PIETSCH, A.  
Ceramic heat exchanger - Applications and  
developments 21 p0050 A79-12826
- PILAND, R. O.  
The solar power satellite concept evaluation program 21 p0107 A79-16602
- PILIJA, A. D.  
RF-heating in stationary systems 22 p0271 A79-24864
- PILLER, S. J.  
Status of free-piston Stirling engine/linear  
alternator power conversion system development 21 p0025 A79-10212
- PILLSBURY, P. W.  
Investigating combustion turbine burner  
performance with coal derived liquids having  
high fuel bound nitrogen 21 p0033 A79-10791
- [ASME PAPER 78-GT-126] 21 p0033 A79-10791
- PILLSBURY, R. D.  
Fabrication and assembly considerations for a base  
load MHD superconducting magnet system 22 p0235 A79-20534
- PINES, H. S.  
Floating dry cooling, a competitive alternative to  
evaporative cooling in a binary cycle geothermal  
power plant 21 p0159 A79-19775
- [ASME PAPER 78-WA/ENER-2] 21 p0159 A79-19775
- PINKERTON, J. D.  
Catalytic conversion of coal energy to hydrogen 21 p0180 N79-11239
- [FE-2206-14] 21 p0180 N79-11239
- PINKHASIK, D. S.  
U-25B MHD unit for carrying out investigations  
under the conditions of strong electric and  
magnetic fields 21 p0049 A79-12692
- PINKHASIK, H. S.  
Vaporization of drops of a melt of potassium  
carbonate in a medium of combustion products 21 p0167 A79-20411
- PINSON, W. E.  
Measuring the quasi-Fermi level and flat band  
potential of an illuminated Au/n-GaAs/.6/P/.4/  
anode 22 p0317 A79-31411
- PINTO, J.  
The natural and perturbed troposphere 21 p0179 N79-10636
- PISHARODY, R. K.  
Modified silicon-germanium alloys with improved  
performance 21 p0027 A79-10225

- PISHCHIKOV, S. I.  
U-25B MHD unit for carrying out investigations under the conditions of strong electric and magnetic fields  
21 p0049 A79-12692  
Inverter systems  
21 p0106 A79-16486
- PISTOIA, G.  
On the possibility of using silver salts other than Ag<sub>2</sub>CrO<sub>4</sub> in organic lithium cells  
22 p0246 A79-21491
- PISTUNOVICH, V. I.  
Calculation of the Q factor for a two-component tokamak  
22 p0324 A79-31763
- PITASI, M. J.  
A flat plate multiple pass solar collector using aqueous optical properties  
22 p0293 A79-28144  
A parabolic solar reflector for accurate and economic producibility  
22 p0293 A79-28145
- PITTENGER, L. C.  
Large-scale cryopumping for controlled fusion  
21 p0085 A79-15330
- PIVOVAROVA, Z. I.  
Radiation regime of inclined surfaces  
22 p0282 A79-26353
- PLA BARBY, P. E.  
Solid desiccant air conditioning with silica gel using solar energy  
21 p0181 A79-11464
- PLAZA, R.  
Net energy analysis of five energy systems [ORAU/IEA(R)-77-12]  
21 p0174 A79-10534
- PLEASE, C. H.  
The use of wave powered systems for desalination - A new opportunity  
21 p0151 A79-18108
- PLETT, E. G.  
Cylindrical parabolic collector optimization for interfacing with steam turbine generators  
22 p0322 A79-31448
- PLOTKIN, S.  
Public hearing transcript: Federal non-nuclear energy research and development program [PB-287910/4]  
22 p0349 A79-18464
- PLOYART, R.  
Theoretical and experimental yields of a solar heater with flat plate collectors  
21 p0134 A79-17437
- PLUMPTON, B.  
Integrating wave power into the electricity supply system  
21 p0152 A79-18117
- PLUNKETT, A. B.  
Laboratory evaluation of a composite flywheel energy storage system  
21 p0013 A79-10110
- PLUST, R. G.  
Recent developments in power sources with special emphasis on alkaline batteries  
22 p0301 A79-29490
- POBEREZHSKII, L. P.  
Mathematical model of interelectrode breakdown in MHD generator  
21 p0167 A79-20418  
Construction of a mathematical model for MHD generator electrodes in the arc regime of operation  
22 p0258 A79-23138
- POCH, L. A.  
Optimum selection of a wind turbine generator system [AIAA PAPER 78-1774]  
21 p0062 A79-13871
- POCHE, A. J.  
Preliminary design of the solar total energy-large scale experiment at Shenandoah, Georgia  
21 p0019 A79-10159
- PODOLSKI, W. F.  
Pressurized fluidized-bed combustion/component test and integration unit preliminary design report  
21 p0008 A79-10076
- PODOLITSEV, A. D.  
Electromechanical conversion of energy during the deceleration of a piston in a uniform magnetic field  
22 p0309 A79-30599
- POHL, J. H.  
Combustion research on the fate of fuel-nitrogen under conditions of pulverized coal combustion [PB-286208/4]  
21 p0232 A79-15474
- POIRIER, R. H.  
A summary of R&D programs  
21 p0146 A79-17639
- POISSON-QUINTON, P.  
Energy conservation aircraft design and operational procedures [ONERA, TP NO. 1978-107]  
21 p0036 A79-11572  
Energy conservation aircraft design and operational procedures  
21 p0202 A79-13200
- POLLABERT, T. J.  
Synthetic fuels from coal  
21 p0145 A79-17636
- POLLARD, F.  
Influence of marketing requirements on definition of coal resources  
22 p0340 A79-17319
- POLLARD, H. E.  
Intelsat V solar array design and development summary  
21 p0002 A79-10018
- PONPON, J. P.  
Interface properties and stability of Schottky barriers and MIS solar cells  
21 p0123 A79-17342
- PONT, R. J.  
An introduction to ocean thermal energy conversion /OTEC/ power plants  
21 p0091 A79-15869
- POPA, R.  
Optimal decisions for long-term operation of hydropower systems  
22 p0245 A79-21473
- POPE, G. G.  
Prospects for reducing the fuel consumption of civil aircraft  
22 p0325 A79-31911
- POPE, H. D.  
Field tests of photovoltaic power systems [ASME PAPER 79-SOL-10]  
22 p0308 A79-30545
- POPE, W. L.  
Floating dry cooling, a competitive alternative to evaporative cooling in a binary cycle geothermal power plant [ASME PAPER 78-WA/ENER-2]  
21 p0159 A79-19775
- POPOV, P. G.  
Problems in the development of high-service-life capacitative accumulators  
22 p0243 A79-21249
- POPOVA, V. A.  
Problems in the development of high-service-life capacitative accumulators  
22 p0243 A79-21249
- PORTER, T. G.  
Dynamic response of a wind turbine system and its effect on performance  
21 p0067 A79-14293
- POSNER, D.  
Design optimization for solar array of multiple collector types  
21 p0071 A79-14677
- POSNER, D. M.  
Estimating hourly solar radiation for one-axis tracking focusing collectors  
21 p0071 A79-14678  
Barriers and incentives to the commercialization of solar heating and cooling of buildings  
21 p0072 A79-14687
- POSTNIKOVA, I. M.  
Dynamic characteristics of a free-piston diesel engine combined with a MHD generator  
22 p0258 A79-23137
- POTTIER, H.  
Underground gasification of coal at deep levels - Perspectives and problems  
21 p0156 A79-19401
- POUBEAU, P. C.  
Development of a satellite flywheel family operating on one active axis magnetic bearings  
22 p0366 A79-21392
- POUGET-ABADIE, I.  
Production of mechanical energy by thermodynamic conversion of solar energy  
22 p0310 A79-30999

C-6

- POULIOT, H. H.  
Variable-displacement spark-ignition engine  
[SAND-77-8299] 21 p0172 N79-10435
- POULOS, H. E.  
Preliminary results from the Georgia Tech 400 kwth  
Solar Thermal Test Facility 21 p0141 A79-17499
- POURING, A. A.  
Quasi-equilibrium Air Standard heat balanced cycle  
analysis 21 p0028 A79-10232
- POWE, R. E.  
Thermal modeling of coal-fired MHD plant components  
21 p0017 A79-10138  
Gas stream composition and temperature  
determination in a coal-fired MHD simulation  
facility  
[ASME PAPER 78-WA/HT-23] 21 p0161 A79-19810
- POWELL, J.  
The fast power cycle for fusion reactors 21 p0018 A79-10152
- POWELL, J. R.  
The LASH /laser-ash/ particulate fragmentation  
removal concept for coal fired turbine power  
plants 21 p0009 A79-10078  
Hydrogen production from high temperature  
electrolysis and fusion reactor 21 p0015 A79-10126
- POWELL, R.  
A challenging role for the assurance sciences 21 p0086 A79-15396
- PRADHANANGA, R. R.  
Saur vidyut kosh - The solar cell 21 p0126 A79-17371
- PRAGER, R. C.  
Analysis and application of the heat pipe heat  
exchanger 21 p0014 A79-10117  
The analysis of heat transfer with and without  
condensation in a heat pipe heat exchanger  
[ASME PAPER 78-WA/HT-59] 21 p0161 A79-19824
- PRASAD, B. M.  
Saur vidyut kosh - The solar cell 21 p0126 A79-17371
- PRASAD, H. S. K.  
Possibility of production of low cost solar grade  
silicon by trichlorosilane process 21 p0125 A79-17363
- PRAST, G.  
A free-piston Stirling engine for small solar  
power plants 21 p0024 A79-10205
- PRATT, R. B.  
Performance of residential solar heating and  
cooling system with flat-plate and evacuated  
tubular collectors - CSU Solar House I 22 p0276 A79-25939  
Evaluation of high performance evacuated tubular  
collectors in a residential heating and cooling  
system: Colorado State University Solar House 1  
[COO-2577-14] 21 p0206 N79-13507
- PRATT, R. H.  
Environmental conservation concerns in  
transportation: Energy, noise, and air quality  
[PB-286550/9] 21 p0232 N79-15868
- PRELAS, S. A.  
Progress in nuclear-pumped lasers 21 p0110 A79-16627
- PRENTICE, B. A.  
Chemical studies of stack fly ash from a  
coal-fired power plant 22 p0309 A79-30595
- PRESTON, D. H.  
Optimization of PtDoped KOCITE (trade name)  
electrodes in H3PO4 fuel cells  
[AD-A061242] 22 p0342 N79-17340
- PRETO, K. K.  
Calcium/iron sulfide secondary cells 21 p0041 A79-11835
- PRICE, C. W.  
State of the art and science report on design of  
alloys resistant to high-temperature  
corrosion-erosion in coal conversion environments  
[EPRI-PP-557] 21 p0200 N79-13149
- PRICE, J.  
Lead-acid battery: An evaluation of  
commercialization strategies  
[MTE-7593] 21 p0220 N79-14565
- PRICE, W. G., JR.  
SLPX - Superconducting Long-Pulse Tokamak Experiment  
22 p0237 A79-20557
- PRINCE, H. B.  
Photovoltaic overview  
[AIAA PAPER 78-1763] 21 p0061 A79-13864
- PRITCHARD, D. A.  
Combined photovoltaic thermal collector testing  
[SAND-78-1191C] 21 p0198 N79-12570
- PRIVALOV, N. P.  
U-25B MHD unit for carrying out investigations  
under the conditions of strong electric and  
magnetic fields 21 p0049 A79-12692  
Design and operating experience of the cryogenic  
system of the U.S. SCMS as incorporated into the  
bypass loop of the U-25 MHD generator facility  
22 p0235 A79-20532
- PROHAZKA, G. J.  
Solid waste and coal firing in industrial boilers 21 p0096 A79-15918
- PROMO, J. K.  
Energy and Technology Review, June 1978  
[UCRL-52000-78-6] 21 p0215 N79-14168
- PROVENZANO, G.  
Motor vehicle lead emissions in the United States  
- An analysis of important determinants,  
geographic patterns and future trends 21 p0113 A79-16745
- PRIOR, R. A.  
Phase 1 of the automated array assembly task of  
the low cost silicon solar array project  
[NASA-CR-158120] 22 p0348 N79-18451
- PSOPOGIANNAKIS, M. G.  
Cylindrical parabolic collector optimization for  
interfacing with steam turbine generators 22 p0322 A79-31448
- PUCKETT, J. K.  
Environmental assessment for residual oil  
utilization  
[PB-286982/4] 22 p0336 N79-16446
- PUSCHKE, R. F.  
Oxidation of SO2 on the surface of fly ash  
particles under low relative humidity conditions 22 p0277 A79-26038
- PULPREY, D. L.  
An investigation of dark current and photocurrent  
superposition in photovoltaic devices 22 p0291 A79-27871
- PURCELL, J. J.  
The National Program for Solar Energy 21 p0072 A79-14688
- PURCELL, J. R.  
High-current power leads for tokamak fusion  
reactor superconducting magnets 21 p0085 A79-15318
- PURI, G. G.  
A reflector concentrator modified sterling engine  
unit and an aqua-ammonia absorber gas turbine  
unit for farm power needs 21 p0142 A79-17509
- PURI, V. H.  
Solar energy research, development and  
demonstration program in Kuwait 21 p0117 A79-17282
- PURDITT, G. P.  
Utilization of waste heat in trucks for increased  
fuel economy  
[NASA-TN-79966] 21 p0215 N79-13937
- PURONEN, E.  
Regional air pollution study: Heat emission  
inventory  
[PB-284081/7] 21 p0200 N79-12602
- PURSER, P. E.  
Potential producibility and recovery of natural  
gas from geopressured aquifers of the Cenozoic  
sediments of the Gulf Coast Basin  
[FE-2025-3] 21 p0192 N79-11607
- PURVIS, G. D., III  
Magnetically confined plasma solar collector 21 p0109 A79-16617
- PUTHNEY, Z. C.  
Unique aspects of terrestrial photovoltaic system  
design  
[ASME PAPER 79-SOL-14] 22 p0308 A79-30548  
Cast semicrystalline silicon for solar cells  
[ASME PAPER 79-SOL-16] 22 p0309 A79-30550

- PYTLIŃSKI, J. T.**  
Solar energy installations for pumping irrigation water 21 p0066 A79-14260
- Historical developments of the use of solar energy for pumping irrigation water 21 p0076 A79-14762
- Basic technical and economical aspects of the use of solar energy for pumping irrigation water 21 p0076 A79-14763
- Solar energy - Past and present developments 21 p0076 A79-14764

## Q

- QAZI, A. Q.**  
On the use of eddy-current couplings in wind-driven synchronous machines 21 p0113 A79-16742
- QUADE, R. E.**  
High efficiency thermal energy storage system for utility applications 21 p0012 A79-10102
- Energy distribution and storage alternates with a centralized heat source 21 p0013 A79-10112
- QUARDENER, G. J.**  
The Dow Chemical liquefaction process 21 p0147 A79-17644
- QUELL, P.**  
The potential of fusion reactors as process heat source 22 p0284 A79-26624
- QUENTIN, G.**  
Study of integrated gasification combined cycle plant interaction and control [ASME PAPER 79-GT-60] 22 p0306 A79-30530
- QUICK, T. E.**  
Bibliographic and numeric data bases for fiber composites and matrix materials 21 p0114 A79-16984
- QUINNLIAN, S.**  
Environmental assessment data base for high-Btu gasification technology. Volume 1: Technical discussion [PB-288602/6] 22 p0350 N79-18487
- Environmental assessment data base for high-Btu gasification technology. Volume 2: Appendices A, B, and C [PB-288603/4] 22 p0350 N79-18488
- Environmental assessment data base for high-Btu gasification technology. Volume 3: Appendices D, E, and F [PB-288604/2] 22 p0350 N79-18489
- Applicability of petroleum refinery control technologies to coal conversion [PB-288630/7] 22 p0352 N79-19173

## R

- RAAG, V.**  
The application of solar thermoelectric generators in near-sun missions 21 p0023 A79-10187
- Analytical predictions of selenide RTG power degradation 21 p0026 A79-10223
- Comprehensive thermoelectric properties of n- and p-type 78a/o Si - 22a/o Ge alloy 22 p0259 A79-23604
- Design concepts of solar thermoelectric generators in space applications 22 p0260 A79-23612
- RABAS, T. J.**  
Capital cost system optimization of OTEC power modules 21 p0101 A79-16249
- RABKIN, I. I.**  
Steam generator and turbomachines 21 p0106 A79-16489
- RABL, A.**  
Performance of evacuated solar collectors with compound parabolic concentrators 21 p0089 A79-15855
- Simple procedure for predicting long term average performance of nontracking and of tracking solar collectors 21 p0091 A79-15873

- A compound parabolic concentrator for a high temperature solar collector requiring only twelve tilt adjustments per year 21 p0134 A79-17439
- Compound parabolic concentrators with non-evacuated receivers - Prototype performance and a larger scale demonstration in a school heating system 21 p0134 A79-17440
- High temperature solar collector of optimal concentration - Non-focusing lens with secondary concentrator 21 p0135 A79-17448
- RADNER, R. J.**  
Biological solar energy conversion approaches to overcome yield stability and product limitation: [PB-284823/2] 21 p0199 N79-12577
- Biological solar energy conversion: Approaches to overcome yield, stability and product limitations [PB-286487/4] 21 p0230 N79-15422
- RADOSEVICH, L. G.**  
Specific heat variations in oil energy storage media and their economic implications [SAND-78-8672] 21 p0189 N79-11537
- RARUCHE, W.**  
Designing and testing Si3N4 turbine components at Mercedes-Benz 21 p0050 A79-12830
- RAPPELLINI, G.**  
A contribution to evaluation of flat-plate solar collectors performance 21 p0133 A79-17427
- RAPIKOV, H. E.**  
Dynamic model of an industrial plant manufacturing a variety of products 21 p0051 A79-12957
- RAGAINI, R. C.**  
Chemical studies of stack fly ash from a coal-fired power plant 22 p0309 A79-30595
- RAGHUNATH, B. K.**  
A report on the various heat collection and heat storage systems evolved under the solar energy programme at B. I. T. S. 21 p0132 A79-17423
- RAGLAND, K. W.**  
The impact of a coal fired power plant on ambient sulfur dioxide levels 21 p0082 A79-15032
- RAHNKE, C. J.**  
Reliability and durability of ceramic regenerators for gas turbine applications 21 p0050 A79-12823
- RAY-CHOUDEHURY, P.**  
Materials for low-cost solar cells 22 p0252 A79-22099
- Phase two of the array automated assembly task for the low cost solar array project [NASA-CR-158359] 22 p0359 N79-20484
- RAYTHEY, G. D.**  
Methods for reducing heat losses from flat plate solar collectors, phase 2 [COO-2597-4] 21 p0188 N79-11533
- RAJAGOPAL, K.**  
A simulation study of phase change energy store 21 p0120 A79-17318
- RAJAGOPALAN, I.**  
New processes for black coatings useful in harnessing solar energy. I - A room temperature black chromium plating bath 21 p0127 A79-17379
- RAJAGOPALAN, S. R.**  
New processes for black coatings useful in harnessing solar energy. I - A room temperature black chromium plating bath 21 p0127 A79-17379
- RAJAGOPALAN, V.**  
Efficient use of wind energy by using static slip recovery systems - A simulator study 21 p0113 A79-16744
- Contribution to the development of wind energy systems using static power electronic converters 22 p0286 A79-26958
- Control strategy for a variable-speed wind energy conversion system 22 p0303 A79-29800
- RAJAW, R.**  
Simulation of fluidized bed coal combustors [NASA-CR-159529] 22 p0359 N79-20487



## RAJIKANAN, K.

- A better approach to the evaluation of the series resistance of solar cells 22 p0281 A79-26242

## RALEIGH, L. H.

- United States civilian space programs: An overview [GPO-35-823] 21 p0232 N79-15815

## RALLIS, C. J.

- A computer and experimental simulation of Stirling cycle machines 21 p0023 A79-10192

## RALPH, E. L.

- Solar cell workshop 21 p0170 N79-10141

## RANAGE, C. S.

- Oahu wind power survey [PB-287361/0] 22 p0335 N79-16382

## RANAKUNAR, R.

- Operation and control of wind-electric systems 21 p0086 A79-15575  
On the use of eddy-current couplings in wind-driven synchronous machines 21 p0113 A79-16742  
Prospects for harnessing renewable energy sources in developing countries 21 p0117 A79-17286

## RANAN, K.

- A solar energy system with a dual-source heat pump and long-term storage 21 p0119 A79-17312

## RANASESHAN, S.

- New processes for black coatings useful in harnessing solar energy. I - A room temperature black chromium plating bath 21 p0127 A79-17379

## RANOS BERJANO, P.

- Calculation of solar energy incident on non-horizontal surfaces over Turkey 22 p0253 A79-22266

## RANPONI, G.

- Non-thermal emission at the plasma frequency 22 p0270 A79-24854

## RANSEY, J.

- Jet fuels from shale oil - A near term technology 21 p0005 A79-10045

## RANSEY, J. W.

- Heat transfer - A review of 1977 literature 21 p0155 A79-18973

## RANDALL, R. H.

- Practical aspects of designing and manufacturing MHD superconducting base-load magnets in 1988 time frame 22 p0235 A79-20535

## RANGI, R. S.

- NRC's wind energy program 22 p0319 A79-31426

## RANKIN, R. R.

- Insulating wall boundary layer in a Faraday MHD generator [PE-23417] 22 p0365 N79-21310

## RAO, C. V. H.

- Large area silicon sheet by EPG 21 p0123 A79-17340

## RAO, C. V. P.

- A study for optimum use of metallic plates for thermal storage in solar processes 21 p0122 A79-17331

## RAO, D. P.

- Performance of flat plate solar collector with fluid undergoing phase change 21 p0129 A79-17397

## RAO, H. V.

- Design of a solar energy operated lithium-bromide water absorption refrigeration system for refrigeration storage 21 p0143 A79-17523

## RAO, K. R.

- Temperature dependent parameter analysis of thermoelectric devices 21 p0113 A79-16740  
International Conference on Thermoelectric Energy Conversion, 2nd, University of Texas, Arlington, Tex., March 22-24, 1978, Proceedings and Supplement 22 p0259 A79-23603

## RAO, K. S.

- Efficient use of wind energy by using static slip recovery systems - A simulator study 21 p0113 A79-16744

- Performance of flat plate solar collector with fluid undergoing phase change 21 p0129 A79-17397

- Performance of flat plate solar collector with fluid undergoing phase change 21 p0129 A79-17397

- Honeycomb type flat plate collectors - Experiments leading to drinking straw 21 p0132 A79-17424

## RAO, H. R.

- Spectral selective properties of black chrome and nickel electrodeposited coatings for solar absorber 21 p0127 A79-17383

## RAO, H. S. H.

- Structural design of a superheater for a central solar receiver [ASME PAPER 78-WA/PVP-1] 21 p0162 A79-19832

## RAO, T. K.

- Energy-related pollutants in the environment: The use of short-term for mutagenicity in the isolation and identification of biohazards [CONF-780121-2] 21 p0192 N79-11568

## RAO, T. L. S.

- Dynamic response of a novel solar water heater 21 p0140 A79-17488

## RAO, T. V. L.

- Optimising the pitching of tubes in a flat solar collector for increasing the efficiency for use in vapour absorption refrigeration 21 p0132 A79-17422

## RAOUP, N.

- New instrumentation for high temperature and hemispherical measurements of selective surfaces 22 p0294 A79-28152

## RAPHAEL, D. L.

- Water/energy management and evaluation model for Pennsylvania [PB-287577/1] 22 p0343 N79-17353

## RAPOLLA, A.

- Shallow magmatic reservoirs as heat source of geothermal systems - Preliminary interpretation of data available for the Neapolitan active volcanic areas 21 p0075 A79-14727

## RAPPAFORT, E. J.

- Design of superconducting magnets for full-scale MHD generators 21 p0084 A79-15306

## RAPPERPORT, E. J.

- Practical aspects of designing and manufacturing MHD superconducting base-load magnets in 1988 time frame 22 p0235 A79-20535

## RASBAND, J. L.

- Solar One - A 10-megawatt solar thermal central receiver pilot plant project [AIAA PAPER 78-1750] 21 p0060 A79-13853  
10-megawatt solar central receiver pilot plant 21 p0094 A79-15906

## RASER, N. H.

- Flexed beams in central receiver heliostat drives [AIAA PAPER 78-1755] 21 p0060 A79-13856

## RASHCHEPKIN, A. P.

- Two asymptotic solutions for analyzing the transverse edge effect in induction MHD machines 22 p0298 A79-29287

## RASK, D. H.

- Jet impingement solar air heater [AIAA PAPER 78-1760] 21 p0061 A79-13861

## RASOR, N. S.

- A summary of USSR thermonuclear energy conversion activity 21 p0026 A79-10216

## RASULOV, D. T.

- Photoelectric properties of pCdTe-nCdS film heterojunctions 21 p0166 A79-20347  
Calculating the photocurrent and maximum efficiency of film p-CdTe-n-CdS photocells 21 p0166 A79-20354

## RATAJCZAK, A.

- NASA Lewis Research Center photovoltaic application experiments [AIAA PAPER 78-1768] 21 p0061 A79-13867

## RATAJCZAK, A. P.

- Photovoltaic power systems for rural areas of developing countries 22 p0278 A79-26131

## PERSONAL AUTHOR INDEX

REILLY, J. J.

- Photovoltaic power systems for rural areas of developing countries  
[NASA-TN-79097] 21 p0229 N79-15411
- RATCLIFF, G.  
The role of the battery electric vehicle 22 p0301 A79-29491
- RATH, J.  
Roll-out solar arrays - Candidate power sources for future space missions  
[IAP PAPER 78-39] 21 p0038 A79-11216  
Flexible roll-out solar generators - Energy sources for future high-power space missions  
[DGLR PAPER 78-165] 21 p0063 A79-14056
- RATH, L. K.  
Process development for the Westinghouse advanced fluidized-bed coal gasification system 21 p0006 A79-10058
- RATHER, J. D. G.  
New candidate lasers for power beaming and discussion of their applications 21 p0110 A79-16622
- RATHJEN, S. M.  
A microwave power transmission system for space satellite power 21 p0002 A79-10025  
Microwave phased array design considerations for SPS 21 p0003 A79-10031
- RAUH, R. D.  
The secondary lithium electrode in non-aqueous electrolytes - Some problems, some solutions 21 p0041 A79-11838  
A lithium/dissolved sulfur battery with an organic electrolyte 22 p0305 A79-30332
- RAVI, K. V.  
Large area silicon sheet by EPG 21 p0123 A79-17340
- RAY, A.  
Preliminary controller evaluation for the MERC/CTIU using a mathematical process model 21 p0008 A79-10073
- RAYL, G.  
Ultralow-mass solar-array designs for Halley's comet rendezvous mission 21 p0020 A79-10169
- RAYL, G. J.  
Conceptual approach study 200 watt per kilogram solar array, phase 3  
[NASA-CR-158046] 21 p0219 N79-14551
- RAYMOND, D. R.  
Advanced processes for more efficient use of forest products residual material 21 p0096 A79-15919
- RAZA, A.  
Preparation and properties of pure and tin doped indium oxide selective coatings 21 p0127 A79-17381
- RAEDOBARIN, G. T.  
Laser measurements of the radial profiles of the electron temperature and density in the FT-1 tokamak 22 p0244 A79-21430
- RAZINKOV, V. V.  
Thermal converters with transverse thermoelectromotive forces 22 p0256 A79-22847
- REA, M.  
Electrostatic precipitation tests with fuel oil ash 22 p0296 A79-28390
- READER, G. T.  
Aspects of pulsating combustion 21 p0008 A79-10072  
The Pseudo Stirling cycle - A suitable performance criterion 21 p0023 A79-10196
- REAR, L.  
Sensitivity of slope measurements on parabolic solar mirrors to positioning and alignment of the laser scanner  
[SAND-78-0700] 21 p0185 N79-11496
- REARDON, P. J.  
Status report on TPTR 22 p0290 A79-27669
- REBIBO, K.  
System for projecting the utilization of renewable resources. SPURR methodology  
[ERHQ/2322-77/4] 21 p0174 N79-10538
- REDDOCH, T. W.  
No ill winds for New Mexico utility 22 p0286 A79-27208
- REDDY, G. L.  
Design of a solar energy operated lithium-bromide water absorption refrigeration system for refrigeration storage 21 p0143 A79-17523
- REDDY, G. N.  
Advanced processes for generation of electric power - Solvent refining of coal and combined cycle plants 21 p0064 A79-14110
- REDKIN, V. B.  
Turbulence of a combustion product plasma in an MHD channel 22 p0246 A79-21538
- REED, K. A.  
Inclination dependence of pyranometer sensitivity 22 p0295 A79-28154
- REED, R. P.  
Instrumentation for in situ coal gasification. II - Thermal and gas sampling diagnostic techniques 21 p0032 A79-10520
- REED, W. E.  
Cryogenic refrigeration, volume 2. A bibliography with abstracts  
[NTIS/PS-78/1261/3] 22 p0331 N79-16144  
Cryogenic refrigeration, volume 3. A bibliography with abstracts  
[NTIS/PS-78/1262/1] 22 p0331 N79-16145
- REEDY, R. D., JR.  
A composite-rim flywheel design 22 p0240 A79-20840
- REBNAT, A.  
Low-Btu gas from the IGT ash-agglomeration gasification process 21 p0009 A79-10077
- REICHARD, T.  
Provisional flat plate solar collector testing procedures  
[PB-283721/9] 21 p0198 N79-12571
- REICHERT, J. D.  
Non-adaptive optics for solar thermal electric power 21 p0112 A79-16733
- REID, G. W.  
Energy conservation through source reduction  
[PB-290126/2] 22 p0372 N79-21626
- REID, M. A.  
An improved method for analysis of hydroxide and carbonate in alkaline electrolytes containing zinc 21 p0035 A79-11546  
Factors affecting the open-circuit voltage and electrode kinetics of some iron/titanium/redox flow cells 21 p0040 A79-11824
- REID, M. S.  
Calibration standards and field instruments for the precision measurement of insolation 21 p0076 A79-14765  
A probabilistic model of insolation for the Mojave desert-area 21 p0076 A79-14766
- REID, W. L.  
Cost analysis and optimization study for solar heating and cooling systems, Stillwater, Minnesota and Newcastle, Pennsylvania  
[NASA-CR-161201] 22 p0358 N79-20478  
Cost analysis and optimization study for solar heating and cooling systems  
[NASA-CR-161200] 22 p0360 N79-20499
- REIDELBACH, R.  
Theoretical studies of coal pyrolysis in an entrained bed flow reactor 21 p0007 A79-10063
- REIHAN, T. C.  
Experimental measurements and correlations of Nusselt number for MHD high temperature air preheaters  
[ASME PAPER 78-WA/HT-22] 21 p0161 A79-19809
- REILLY, J. J.  
Synthesis and properties of useful metal hydrides - A review of recent work at Brookhaven National Laboratory 22 p0250 A79-21699  
Applications of metal hydrides 22 p0251 A79-21715

- REINHARTZ, K. K.  
Energy for Europe from space  
European aspects of Solar Satellite Power systems  
22 p0273 A79-25605  
22 p0326 A79-31923
- REISS, R.  
Testing the efficiency of solar collectors  
21 p0056 A79-13627
- REISTAD, G. E.  
A thermodynamic study of heating with geothermal energy  
[ASME PAPER 77-WA/ENER-1]  
Thermosyphon models for downhole heat exchanger applications in shallow geothermal systems  
21 p0030 A79-10253  
21 p0150 A79-18092
- REISTER, D. E.  
Net energy analysis of five energy systems  
[ORAU/IEA(R)-77-12]  
21 p0174 N79-10534
- RENNER, D. S.  
Wind characteristics program element  
[PNL-2545]  
22 p0356 N79-19568
- RESHOTKO, E.  
Drag reduction by cooling in hydrogen fueled aircraft  
21 p0165 A79-20084
- RETHNER, B.  
A challenging role for the assurance sciences  
21 p0086 A79-15396
- RETTICH, G.  
Control of solar energy systems, heat storage, and heat utilization  
21 p0056 A79-13630
- REUTER, R. C., JR.  
Torque ripple in a vertical axis wind turbine  
21 p0029 A79-10239
- REYER, R.  
USAF terrestrial energy study. Volume 3, part 1: Summary data display  
[AD-A061071]  
22 p0342 N79-17341
- REYLER, R. S.  
Selenide thermoelectric converter technology  
21 p0026 A79-10221
- REZNER, B.  
An annotated compilation of the sources of information related to the usage of electricity in non-industrial applications  
[PB-285260/6]  
21 p0212 N79-13552
- REZNER, S. E.  
Energy/environment technology areas to be developed  
21 p0097 A79-16077
- RHODENIZER, E.  
Design of superconducting magnets for full-scale MHD generators  
21 p0084 A79-15306
- RHODES, G. W.  
Solar Thermal Electric Program  
21 p0112 A79-16730
- RHODES, W. J.  
Denatallization catalyst tests on heavy residual oils  
[PB-285937/9]  
21 p0232 N79-15864
- RHOTE, W. E.  
An evolutionary solar power satellite program  
[AAS PAPER 78-153]  
22 p0243 A79-21265
- RIABIKOV, S. V.  
New models of solar cells and prospects for their optimization  
21 p0166 A79-20346
- Solar-to-thermal energy converter based on coaxial evacuated tubular elements with multilayer and selective coatings  
21 p0167 A79-20356
- RIAE, H.  
Long-term storage of solar energy in native rock  
21 p0120 A79-17314
- RIBBING, C. G.  
Colored stainless steel - A new type of selective absorber  
22 p0294 A79-28150
- RICE, C. K.  
Analytical methods for evaluating two-dimensional effects in flat-plate solar collectors  
21 p0181 N79-11462
- RICE, G.  
Conversion of a standard single cylinder I.C. engine into a 'gamma' configuration air charged Stirling engine  
21 p0024 A79-10202
- RICE, I. G.  
The combined reheat gas turbine/steam turbine cycle. I - A critical analysis of the combined reheat gas turbine/steam turbine cycle  
[ASME PAPER 79-GT-7]  
22 p0306 A79-30505
- The combined reheat gas turbine/steam turbine cycle. II - The LM 5000 gas generator applied to the combined reheat gas turbine/steam turbine cycle  
[ASME PAPER 79-GT-8]  
22 p0306 A79-30506
- RICE, P. L.  
Energy availabilities for state and local development: 1973 data volume  
[ORNL/TN-5890-S2]  
21 p0175 N79-10541
- Energy availabilities for state and local development: 1974 data volume  
[ORNL/TN-5890-S3]  
21 p0175 N79-10542
- Energy availabilities for state and local development: Projected energy patterns for 1980 and 1985  
[ORNL/TN-5890/54]  
21 p0186 N79-11511
- RICE, R. E.  
NaOH-based high temperature heat-of-fusion thermal energy storage device  
21 p0012 A79-10106
- Phase change thermal storage for a solar total energy system  
21 p0120 A79-17321
- Development of a phase-change thermal storage system using modified anhydrous sodium hydroxide for solar electric power generation  
[NASA-CR-159465]  
22 p0354 N79-19454
- RICE, W. E.  
Macro-energy model - Impact of public policy on technological development  
21 p0113 A79-16741
- RICH, C. H., JR.  
Projects to expand energy sources in the western states  
[PB-283706/0]  
21 p0190 N79-11547
- RICHARDS, T. R.  
DOE/NASA Mod-OA wind turbine performance  
21 p0028 A79-10235
- RICHARDS, W. D. C.  
Performance of a Stirling engine powered heat activated heat pump  
21 p0011 A79-10098
- RICHELS, R. G.  
Exploring future energy options - An economic analysis  
21 p0068 A79-14324
- RICHTER, E.  
Laboratory evaluation of a composite flywheel energy storage system  
21 p0013 A79-10110
- RICHTMYER, T. E.  
The use of computer-controlled data acquisition systems in determining solar heating and cooling system performance  
21 p0088 A79-15834
- RIBBOLD, G.  
Solar water heating  
[BHPT-PB-T-77-42]  
22 p0349 N79-18457
- RIEKE, K. L.  
Program to establish ceramic technology readiness for large combustion turbine utility application  
[ASME PAPER 78-WA/GT-8]  
21 p0160 A79-19796
- RIENCKER, F., JR.  
Diagnostics of Shiva Nova high-yield thermonuclear events  
22 p0285 A79-26747
- RIETHMUELLER, E.  
Review of the Rhein-Flugzeugbau Wankel powered aircraft program  
22 p0329 N79-15966
- RIETJENS, L. H. T.  
Performance of a closed-cycle MHD generator with molecular impurities  
22 p0283 A79-26524
- Experimental investigation on the discharge structure in a noble gas MHD generator  
[TH-78-B-79]  
22 p0350 N79-18758
- RILEY, J. G.  
Forest residues as an alternate energy source  
21 p0072 A79-14689
- RIORDAN, J. C.  
Minimum-average-B wells in linked magnetic mirror fields  
22 p0252 A79-22237

- RITCHIE, I. T.  
DC reactively sputtered metal carbide and metal  
silicide selective absorbing surfaces  
21 p0126 A79-17377
- RIZOS, I.  
Intelsat V solar array design and development  
summary  
21 p0002 A79-10018
- RIZSON, E.  
Performance predictions of a LiBr absorption air  
conditioner utilizing solar energy  
21 p0139 A79-17482
- ROACH, P.  
The economic performance of passive solar heating  
- A preliminary analysis  
[AIAA PAPER 78-1761] 21 p0061 A79-13862  
Impacts of the National Energy Plan on solar  
economics  
[CONF-771203-6] 21 p0118 A79-17294
- ROBBINS, W. E.  
Utility operational experience on the NASA/DOE  
MOD-0A 200-kW wind turbine  
[NASA-TN-79084] 22 p0360 N79-20494
- ROBERTS, G. T.  
Heat loss characteristics of an evacuated  
plate-in-tube collector  
22 p0285 A79-26818
- ROBERTS, J. O.  
Coal and nuclear: A comparison of the cost of  
generating baseload electricity by region  
[PB-289585/2] 22 p0355 N79-19469
- ROBERTS, M. L.  
Method for making an aluminum or copper substrate  
panel for selective absorption of solar energy  
[NASA-CASE-NFS-23518-1] 21 p0182 N79-11469
- ROBERTS, P. B.  
Soot and the combined cycle boiler  
[ASME PAPER 79-GT-67] 22 p0307 A79-30533
- ROBERTS, P. B.  
On the diffusive instability of some simple steady  
magnetohydrodynamic flows  
22 p0278 A79-26163
- ROBIDART, C. M.  
Conceptual design of large heat exchangers for  
ocean thermal energy conversion  
[ASME PAPER 78-WA/HT-32] 21 p0161 A79-19813
- ROBIN, A. M.  
Gasification of coal liquefaction residues  
21 p0006 A79-10059
- ROBINOV, C. J.  
Current and potential uses of aerospace technology  
by the U.S. Department of the Interior  
[AIAA PAPER 78-1716] 21 p0060 A79-13833
- ROBINSON, C. W.  
Variable-displacement spark-ignition engine  
[SAND-77-8299] 21 p0172 N79-10435
- ROBINSON, J. E.  
Energy analysis of an aluminum solar collector  
22 p0316 A79-31405
- ROBINSON, B. I.  
Liquid desiccant solar air conditioner and energy  
storage system  
21 p0021 A79-10176
- ROBLES, T. C.  
Reducing combustion air temperature variations in  
magnetohydrodynamic/steam power plants  
21 p0016 A79-10135
- ROBSON, F. L.  
Second-generation integrated coal  
gasification/combined-cycle power systems  
[ASME PAPER 78-GT-18] 21 p0032 A79-10778
- ROCHE, E. P.  
Electrochemistry of lithium/metal sulfide and  
calcium/metal sulfide cells using molten salt  
electrolytes  
21 p0040 A79-11832  
Calcium/iron sulfide secondary cells  
21 p0041 A79-11835
- RODE, C. E.  
High energy physics superconducting magnets and  
cryogenic systems  
22 p0290 A79-27663
- RODGERS, C.  
Design and development of a monorotor gas turbine  
auxiliary power unit  
[ASME PAPER 78-WA/GT-2] 21 p0160 A79-19791
- RODGERS, M. E.  
Coal slag effects in MHD generators  
21 p0080 A79-14934
- ROGALSKI, W. W., JR.  
Technology considerations in the design of a  
commercial offshore energy conversion /OTEC/ plant  
22 p0288 A79-27378
- ROGERS, E. A.  
Investigation of the corrosion performance of  
boiler, air heater, and gas turbine alloys in  
fluidized combustion systems  
21 p0080 A79-14931
- ROGERS, J. D.  
30-MJ superconducting magnetic energy storage  
/SMES/ unit for stabilizing an electric  
transmission system  
22 p0237 A79-20555
- ROGERS, W.  
A cost effective total energy system using a  
faceted mirror sunlight concentrator and high  
intensity solar cells  
21 p0135 A79-17446
- ROGISTER, A.  
Asymptotic theory of dissipative trapped electron  
mode overlapping many rational surfaces  
22 p0270 A79-24855
- ROGOFF, P.  
SLPI - Superconducting Long-Pulse Tokamak Experiment  
22 p0237 A79-20557
- ROGOSHEWSKI, P. J.  
Standards of Practice Manual for the solvent  
refined coal liquefaction process  
[PB-283028/9] 21 p0178 N79-10595
- ROHATGI, A.  
Phase two of the array automated assembly task for  
the low cost solar array project  
[NASA-CR-158359] 22 p0359 N79-20484
- ROHATGI, V. K.  
A collisional plasma rotating between two cylinders  
21 p0049 A79-12694
- ROHDE, A. G.  
Mercury in some New Zealand geothermal discharges  
22 p0257 A79-22925
- ROHDE, P. G.  
Hydropower from a national point of view  
21 p0059 A79-13656
- ROHR, F. J.  
Economic prospects for the application of new  
electric energy storage devices  
22 p0246 A79-21490  
Development of high temperature fuel cell battery  
[BHFT-PB-T-77-17] 22 p0342 N79-17344
- ROHRMANN, C. A.  
Chemical production from waste carbon monoxide:  
Its potential for energy conservation  
[BNWL-2137] 21 p0170 N79-10179
- ROIPE, I. M.  
Dynamic stabilization of toroidal discharges in  
weak longitudinal magnetic fields  
22 p0324 A79-31766
- ROLINSKI, E. J.  
Energy and the environment; Proceedings of the  
Fifth National Conference, Cincinnati, Ohio,  
November 1-3, 1977  
21 p0063 A79-14106
- ROHANE, W. E.  
25 kilowatt photovoltaic powered irrigation and  
grain drying experiment  
21 p0143 A79-17519
- ROMAK, E. K.  
Sensible heat storage for solar energy applications  
22 p0322 A79-31449
- ROMANKEVICH, A. V.  
Solar-to-thermal energy converter based on coaxial  
evacuated tubular elements with multilayer and  
selective coatings  
21 p0167 A79-20356
- ROMANOV, A. I.  
Materials  
21 p0106 A79-16491
- ROMANOWSKI, L. J., JR.  
Oil recovery from a Utah tar sand deposit by in  
situ combustion  
21 p0004 A79-10043
- ROM, E.  
Heat transfer characteristics of porous metallic  
matrix metal-hydrides  
22 p0251 A79-21706
- ROOT, D. B.  
Current solar applications and economics  
21 p0099 A79-16134

- RORSTE, D. S.  
Particulate and sulfur dioxide emission control costs for large coal-fired boilers [PB-281271/7] 21 p0178 N79-10591
- ROSARD, D. D.  
Working fluids and turbines for OTEC power systems 22 p0280 A79-26192
- ROSCHKE, E. J.  
Solar thermal power systems point-focusing distributed receiver /PPDR/ technology - A project description [AIAA PAPER 78-1771] 21 p0062 A79-13869
- ROSCHKE, E. A.  
Analysis and design of solar buildings using the Cal-ERDA computer programs 21 p0137 A79-17463  
Component-based simulator for solar systems [LA-UR-78-1494] 21 p0208 N79-13521
- ROSE, A.  
The economics of geothermal energy development at the regional level 22 p0256 A79-22756
- ROSE, A. B.  
Buildings energy use data book, edition 1 [ORNL-5363] 22 p0348 N79-18447
- ROSE, P. H.  
Energy exchanger technology applied to laser heated engines 21 p0110 A79-16631
- ROSEEN, R.  
Central solar heat stations and the Studsvik Demonstration Plant 21 p0021 A79-10175
- ROSELL, F. E., JR.  
Recent terrestrial and undersea applications of radioisotope thermoelectric generators /RTGs/ 21 p0027 A79-10226  
Determining the reliability of radioisotope thermoelectric generators /RTGs/ designed for terrestrial and undersea applications 22 p0261 A79-23622  
Recent terrestrial and undersea applications of radioisotope thermoelectric generators /RTGs/ 22 p0261 A79-23623
- ROSEMAN, E. J.  
An economist looks at solar energy - The government's role 21 p0099 A79-16132
- ROSENHART, J. K.  
SNG production by the Rockgas process 21 p0093 A79-15896
- ROSENBERG, L. C.  
The economics of solar heating and cooling - A cautious view 21 p0119 A79-17297
- ROSENBERG, S. A.  
Cost minimization of photovoltaic power supplies 21 p0021 A79-10171
- ROSENBLUM, L.  
Photovoltaic power systems for rural areas of developing countries 22 p0278 A79-26131  
Photovoltaic power systems for rural areas of developing countries [NASA-TN-79097] 21 p0229 N79-15411
- ROSENBLUTH, M. H.  
Non-linear numerical algorithms for studying tearing modes 22 p0257 A79-22981  
MHD stability of Spheromak 22 p0313 A79-31189
- ROSENFELD, A. E.  
Analysis and design of solar buildings using the Cal-ERDA computer programs 21 p0137 A79-17463
- ROSENFELD, S. B.  
Solar energy and the 'Common Heritage of Mankind' [IAP PAPER 78-SL-45] 21 p0035 A79-11356
- ROSENQVIST, K.  
The Stirling engine for automotive application [SAE PAPER 790329] 22 p0315 A79-31370
- ROSS, B.  
Development of economical improved thick film solar cell contact [NASA-CR-158358] 22 p0359 N79-20486
- ROSS, D. W.  
Stability criteria for current-driven drift wave eigenmodes 22 p0269 A79-24813
- ROSS, L. E.  
Calcium/iron sulfide secondary cells 21 p0041 A79-11835
- ROSS, R.  
Simulated hail impact testing of photovoltaic solar panels 21 p0098 A79-16116
- ROSS, R. S.  
Evaluation of urethane for feasibility of use in wind turbine blade design [NASA-CR-159530] 22 p0360 N79-20497
- ROTE, D. H.  
Preliminary assessment of the environmental impacts of the Satellite Power System /SPS/ 22 p0326 A79-31922
- ROTH, W. L.  
Preparation and ionic conductivity of H3O<sup>+</sup>/beta alumina 21 p0040 A79-11821
- ROTHFUS, R. R.  
Heat exchangers for Ocean Thermal Energy Conversion plants 21 p0142 A79-17506
- ROTTY, R. H.  
The atmospheric CO2 consequences of heavy dependence on coal 21 p0107 A79-16524
- ROUKIS, J. G.  
Thermal energy storage heat exchanger design [ASME PAPER 78-ENAS-30] 21 p0049 A79-12579
- ROUNDEGOU, C.  
Experiments in solar space heating and cooling for moderately insulated regions 21 p0137 A79-17464
- ROUT, R. K.  
Simulation of solar powered Rankine cycle systems 21 p0022 A79-10179
- ROWELL, R. H.  
Methanol from wood waste: A technical and economic study [FPL-12] 21 p0194 N79-12239
- ROWLAND, S. J.  
The effect of maturation on the configuration of pristane in sediments and petroleum 22 p0272 A79-25375
- ROWNY, P. E.  
Development of a phase-change thermal storage system using modified anhydrous sodium hydroxide for solar electric power generation [NASA-CR-159465] 22 p0354 N79-19454
- ROY, A. S.  
Economic methodology for solar power-generating systems 21 p0030 A79-10251  
A practical electrochemical transport equation for non-dilute solutions 21 p0041 A79-11841  
Econometric analysis of concentrators for solar cells 21 p0149 A79-18017
- ROY, G. D.  
On supersonic and subsonic diffusers for magnetohydrodynamic generator applications 22 p0279 A79-26186
- ROY, R.  
Black germanium solar selective absorber surfaces 22 p0327 A79-31970
- ROYE, C. E.  
Practical aspects of designing and manufacturing MHD superconducting base-load magnets in 1988 time frame 22 p0235 A79-20535
- RUBIN, E.  
Assessment of the solid waste impact of the National Energy Plan [BNL-50708] 21 p0213 N79-13572
- RUBIN, E. S.  
Energy requirements of a limestone PGD system 21 p0114 A79-16747
- RUCKER, F. H.  
Economic evaluation of the ATC/Wellman incandescent two-stage low Btu coal gas producer 21 p0146 A79-17640
- RUCKMAN, J. B.  
Progress report on hydrogen production and utilization for community and automotive power 21 p0016 A79-10132

# PERSONAL AUTHOR INDEX

SAINT LORANT, S. J.

- RUDEY, R. A.  
Characteristics and combustion of future hydrocarbon fuels 21 p0036 A79-11599
- Impact of future fuel properties on aircraft engines and fuel systems 21 p0036 A79-11600
- Effect of broadened-specification fuels on aircraft engines and fuel systems [AIAA 79-7008] 22 p0300 A79-29383
- Characteristics and combustion of future hydrocarbon fuels 21 p0202 A79-13196
- Impact of future fuel properties on aircraft engines and fuel systems 21 p0202 A79-13197
- Effect of broadened-specification fuels on aircraft engines and fuel systems [NASA-TN-79086] 22 p0330 A79-16136
- RUDGE, A. W.  
A review of some critical aspects of satellite power systems 22 p0326 A79-31921
- RUDEMAN, P. S.  
Thermodynamics of pressure plateaus in metal-hydrogen systems 22 p0238 A79-20772
- RUEDISILI, L. C.  
Perspectives on energy: Issues, ideas, and environmental dilemmas /2nd edition/ 21 p0147 A79-17646
- RUEGG, R. T.  
Life-cycle costing. A guide for selecting energy conservation projects for public buildings [PB-287804/9] 22 p0345 A79-17744
- RUISI, G.  
The relationship between diffuse and total solar radiation in computer simulation of solar energy systems 21 p0119 A79-17304
- RUIZ, J. B.  
Transcell, a novel approach for improving static photovoltaic concentration 21 p0124 A79-17356
- RUP, B.  
Experimental investigations of a physical system capable of using solar energy 22 p0247 A79-21667
- RUPPRECHT, G.  
Sun-position diagrams using examples from Flensburg to Mittenwald. 21 p0055 A79-13626
- RUSEK, S. J.  
Source assessment: Open mining of coal. State of the Art [PB-288497/1] 22 p0353 A79-19429
- RUSH, C. B.  
Preliminary assessment of the environmental impacts of the Satellite Power System /SPS/ 22 p0326 A79-31922
- RUSH, E. E.  
1MW calorimetric receiver for Solar Thermal Test Facility [ASME PAPER 78-WA/SOL-7] 21 p0163 A79-19839
- RUSH, R. E.  
Operating experience with three 20 MW prototype flue gas desulfurization processes [ASME PAPER 78-JPGC-PWR-12] 21 p0150 A79-18098
- RUSSELL, J.  
Low-cost monitoring of solar system performance 21 p0088 A79-15843
- RUSSELL, J. L.  
Measurement of heat loss from a heat receiver assembly of a Fixed Mirror Solar Concentrator 21 p0020 A79-10166
- RUSSELL, J. L., JR.  
Design, construction, and testing of a Fixed Mirror Solar Concentrator field 21 p0020 A79-10164
- Fixed mirror solar concentrator for power generation [GA-A-14883] 21 p0187 A79-11526
- RUSSELL, O. B.  
Remote sensing and mine subsidence in Pennsylvania 22 p0303 A79-29936
- RUSSELL, P. G.  
Electrochemical characteristics of ZrO<sub>2</sub>-Y<sub>2</sub>O<sub>3</sub> solid electrolytes for fuel cells 21 p0039 A79-11813

- RUSSELL, T. W.  
Methane production from carbon oxides over borohydride-reduced transition metals [PB-286385/0] 21 p0226 A79-15177
- RUSSO, G.  
Cavity-type surfaces for solar collectors 22 p0283 A79-26497
- RUSTA, D.  
Nickel-cadmium battery reconditioning and long term performance in geosynchronous orbit spacecraft 21 p0029 A79-10242
- RUTZ, W.  
Development and application of techniques to evaluate cogeneration impacts 22 p0303 A79-29795
- RUZIC, B.  
How to tap NASA developed technology 21 p0164 A79-19896
- RYAN, P. B.  
Magnetic multipole line-cusp plasma generator for neutral beam injectors 22 p0238 A79-20746
- RYAN, R. S.  
Commercialization of fluidized-bed combustion systems by the State of Ohio 21 p0096 A79-15923
- RYANSON, P. B.  
Solar photolysis of water [NASA-CASE-WFO-14126-1] 21 p0182 A79-11470
- REAEV, P. P.  
Thermal calculations for the reactor of a solar-power unit to produce hydrogen by thermolysis of water 21 p0167 A79-20360
- RZHEVSKII, S. V.  
A problem of optimizing the setting angle of sun-battery panels of concave shape 21 p0045 A79-12186
- Determining optimal angles of nonconvex solar battery panel mounting 21 p0080 A79-14837

## S

- SAARI, D. P. GAMESON  
Progress in the testing of materials and design concepts for directly-fired MHD air heater service 21 p0017 A79-10141
- SABBERWAL, S. P.  
Some aspects towards the performance evaluation and ensuing design components of solar collector systems 21 p0130 A79-17404
- SACK, B.  
The potential of fusion reactors as process heat source 22 p0284 A79-26624
- SADLER, J. W.  
Development, testing and evaluation of MHD materials and component designs [FE-2248-19] 22 p0369 A79-21558
- SAPONOVA, S. S.  
Dynamic characteristics of a free-piston diesel engine combined with a MHD generator 22 p0258 A79-23137
- SAGER, J. C.  
Flat plate collector dynamic evaluation 21 p0128 A79-17390
- SAHA, B.  
Role of the diode exponential factor in CdS solar cells 21 p0123 A79-17348
- SAHAI, B.  
High-efficiency AlGaAs/GaAs concentrator solar cells 22 p0261 A79-23710
- SAINI, J. S.  
Return flow solar air-heater 21 p0055 A79-13609
- Solar collector optimization 21 p0132 A79-17418
- Design of solar heating system for winter heating of buildings /A case study/ 21 p0139 A79-17486
- SAINT LORANT, S. J.  
Applied Superconductivity Conference, Pittsburgh, Pa., September 25-28, 1978, Proceedings 22 p0235 A79-20526

- SAINT-ETIENNE, J.  
High accuracy off-shore position finding using the  
GEOLE satellite based system 22 p0329 N79-15932
- SAKR, I. A.  
Possibilities for solar energy utilization in Egypt 21 p0102 A79-16453  
A channelled solar flat-plate booster 21 p0131 A79-17413
- SAKUTA, K.  
Solar thermal energy storage using heat of  
dilution - Analysis of heat generation in  
multistage mixing column 21 p0046 A79-12271  
Estimation of collector and electrical energy cost  
for STEPS in Japan 21 p0118 A79-17288  
An analysis of a cylindrical parabolic focussing  
collector for distributed collector power system 21 p0134 A79-17442
- SALARIYA, K. S.  
Solar concentrators 21 p0136 A79-17455
- SALEEM, A.  
Particulate and sulfur oxide control options for  
conventional coal combustion 21 p0092 A79-15883
- SALIEVA, R. B.  
Selection of method for calculating the parameters  
of wind and solar power station storage facilities 21 p0054 A79-13293  
Fundamentals of mathematical modeling of  
solar-radiation regime energy structure 21 p0166 A79-20352
- SALKELD, R.  
Financial/management scenarios for a satellite  
power system program [AAS PAPER 78-144] 22 p0243 A79-21259
- SALONAA, R. E. E.  
Effects of nonlinear decay of backscattered light  
on the anomalous reflectivity 22 p0310 A79-30742
- SALTER, R. H.  
Application of electron beams in space for energy  
storage and optical beam generation 21 p0108 A79-16606
- SALVADOR, L. A.  
Process development for the Westinghouse advanced  
fluidized-bed coal gasification system 21 p0006 A79-10058  
Westinghouse fluidized bed coal gasification  
system - Experience and plans 21 p0096 A79-15924
- SALYER, I. O.  
Form-stable, crystalline polymer pellets for  
thermal energy storage 21 p0013 A79-10107
- SALZANO, P. J.  
Hydrogen production from high temperature  
electrolysis and fusion reactor 21 p0015 A79-10126
- SANPATH, V.  
Partial processes and transport parameters in  
molten carbonate fuel cell operation 21 p0040 A79-11819
- SANUKELSON, R. S.  
Low head power generation with bulb turbines 21 p0074 A79-14705
- SANAI, M.  
Compartmental model for agricultural conversion of  
solar energy into fixed biomass 21 p0022 A79-10181
- SANBORN, Y.  
The Brookhaven buildings energy conservation  
optimization model [BNL-50828] 22 p0370 N79-21564
- SANCHEZ, L. E.  
The application of photovoltaic roof shingles to  
residential and commercial buildings 21 p0020 A79-10170
- SANCIER, K. H.  
Novel duplex vapor electrochemical method for  
silicon solar cells [NASA-CR-158039] 21 p0218 N79-14537
- SANDBERG, J. J.  
User experience with on-road electric vehicles in  
the U.S.A. and Canada 21 p0009 A79-10080
- SANDER, W. J.  
Energy requirements for producing steel in the  
Republic of South Africa. 22 p0340 N79-17322
- SANDO, M.  
The testing procedures of thermal performance of  
solar collector at Solar Research Lab., G.I.R.I. 21 p0130 A79-17409
- SANDROCK, G. D.  
The metallurgy and production of rechargeable  
hydrides 22 p0250 A79-21703
- SANDS, M. D.  
Environmental considerations for siting an ocean  
thermal conversion early ocean testing platform  
at four proposed areas 22 p0287 A79-27377
- SANDSTEDE, G.  
On the mechanism of the electrocatalytic oxygen  
reduction with particular regard to metal chelates 21 p0038 A79-11808
- SANDSTRON, W. A.  
Low-Btu gas from the IGT ash-agglomeration  
gasification process 21 p0009 A79-10077
- SANGHI, A. K.  
The ground water and energy supply situation for  
Great Plains irrigation [PB-286002/1] 21 p0222 N79-14586
- SANJURJO, A.  
Novel duplex vapor electrochemical method for  
silicon solar cells [NASA-CR-158039] 21 p0218 N79-14537
- SANKAR, S.  
Optimization of a novel hydrostatic drive  
performance using hybrid computing technique 22 p0264 A79-23809
- SANKARANARAYANAN, S.  
Application of turbopack in solar energy systems 21 p0141 A79-17504
- SANKHILA, V. K.  
A reflector concentrator modified sterling engine  
unit and an aqua-ammonia absorber gas turbine  
unit for farm power needs 21 p0142 A79-17509
- SANTODONATO, J.  
Health effects associated with diesel exhaust  
emissions, literature review and evaluation [PB-289817/9] 22 p0364 N79-20727
- SANTY, H. J.  
Coal desulfurization test plant status - July 1977 21 p0044 A79-12118
- SARADA, T.  
Definition of chemical and electrochemical  
properties of a fuel cell electrolyte [AD-A058795] 21 p0206 N79-13503
- SARKISIAN, P. B.  
Advanced wind furnace systems for residential and  
agricultural heating and electrical supply  
applications 21 p0028 A79-10237
- SAROFIN, A. F.  
Flame emissivities - Alternative fuels 21 p0052 A79-12984  
Combustion research on the fate of fuel-nitrogen  
under conditions of pulverized coal combustion [PB-286208/4] 21 p0232 N79-15474
- SARONEN, J.  
Gas turbine with waste heat utilization - Low  
investment costs and high fuel use efficiency 21 p0168 A79-20448
- SAROYAN, R. A.  
Requirements and new materials for fusion laser  
systems 21 p0082 A79-15138
- SARRIDIN, J.  
Hydrogen electrochemical storage by substituted  
LaNi5 compounds 22 p0251 A79-21711
- SASAKI, J. E.  
Mississauga solar house /Mississauga, Ontario,  
Canada/ 22 p0276 A79-25935  
Studies on solar collector performance at NRC 22 p0322 A79-31451
- SASTRI, V. M. K.  
A study for optimum use of metallic plates for  
thermal storage in solar processes 21 p0122 A79-17331

- SASTROAMIDJOJO, M. S. A.  
Flux-redistribution in the focal region of a planar Fresnel ring mirror 22 p0263 A79-23764
- SATCHWELL, D. L.  
Composite material flywheel for the electric-powered passenger vehicle 22 p0240 A79-20842
- SATER, B. L.  
A cost effective total energy system using a faceted mirror sunlight concentrator and high intensity solar cells 21 p0135 A79-17446
- SATHE, A. P.  
A simple solar tracking system 21 p0136 A79-17457
- SATO, H.  
Superconducting energy storage magnets 22 p0236 A79-20537
- SAUER, H. J.  
Heat recovery devices for building HVAC systems 21 p0073 A79-14697
- SAV, G. T.  
Life-cycle costing. A guide for selecting energy conservation projects for public buildings [PB-287804/9] 22 p0345 A79-17744
- SAVAGE, J. A.  
Energy conservation by means of recycling 21 p0112 A79-16735
- SAVCHENKO, I. G.  
Experimental investigation of the joint operation of wind and solar plants 21 p0167 A79-20358
- SAVERY, C. W.  
Double-exposure collector system for solar heating applications 21 p0131 A79-17411
- SAVINELL, R. P.  
Discharge characteristics of a soluble iron-titanium battery system 22 p0286 A79-26996
- SAVADA, Y.  
Flywheel energy storage system for JT-60 toroidal field coil 21 p0112 A79-16729
- SAWAN, Y.  
Photovoltaic effect in metal-insulator-semiconductor structure 21 p0123 A79-17343
- SAWATA, S.  
Solar thermal energy storage using heat of dilution - Analysis of heat generation in multistage mixing column 21 p0046 A79-12271  
Estimation of collector and electrical energy cost for STEPS in Japan 21 p0118 A79-17288  
An analysis of a cylindrical parabolic focussing collector for distributed collector power system 21 p0134 A79-17442
- SAWYER, C. J.  
State-of-the-art assessment of air pollution control technologies for various waste-as-fuel processes 21 p0064 A79-14111
- SAWYER, D. E.  
Measurement techniques for solar cells [PB-287519/3] 22 p0343 A79-17352
- SAYIGH, A. A. M.  
Saudi Arabia looks at the sun 21 p0063 A79-13900  
A comparison among various flat plate collectors with honeycomb structures 21 p0128 A79-17392  
Effect of dust on flat plate collectors 21 p0129 A79-17399
- SBITNIKOVA, I. S.  
Properties of the plasma ions and the particle lifetime in ohmic heating in the L-2 stellarator 22 p0244 A79-21428
- SCALABRIN, G.  
Performance predictions of a LiBr absorption air conditioner utilizing solar energy 21 p0139 A79-17482
- SCHAPPERT, M. J.  
A calculation of linear magnetic liner fusion reactor performance 21 p0018 A79-10153
- SCHAPPT, B. A.  
Measurement techniques for solar cells [PB-287519/3] 22 p0343 A79-17352
- SCHAIKKE, E. B.  
A fundamental model for the evolution of a two-phase geothermal reservoir with application to environmental impact analysis 22 p0263 A79-23777
- SCHALLER, B. G. A.  
Solar energy in Southern Africa 21 p0117 A79-17287
- SCHALLER, E. S.  
Development and evaluation of a 600-kWh lithium-hydrogen peroxide reserve power system 21 p0011 A79-10095
- SCHAPPERT, G. T.  
Prepulse damage to targets and alignment verification 22 p0258 A79-23027
- SCHARY, F.  
The Trithem test house 22 p0290 A79-27723
- SCHIEDLER, W. J.  
Synchronous meteorological and geostationary operational environmental satellites battery and power system design 22 p0370 A79-21571
- SCHIEL, E. W.  
Dynamic behaviour of light-weight solar collectors 21 p0056 A79-13628
- SCHIEBER, S. R.  
Federal automobile fuel economy standards - A status report 21 p0073 A79-14693
- SCHIEITHAUER, R.  
Distributed energy storage for solar applications 22 p0317 A79-31410
- SCHENK, K. F.  
Performance analysis of a flat-plate solar collector using 'forge-fin' tubes 22 p0316 A79-31404  
Thermal performance evaluation of a flat-plate cylindrical parabolic concentrator and a flat-plate collector 22 p0317 A79-31408
- SCHERBER, W.  
Selective coatings for aluminum and steel solar absorbers 21 p0058 A79-13647
- SCHERNER, E. I.  
Conductor for LASL 10-MWhr superconducting energy storage coil 21 p0085 A79-15309  
30-MJ superconducting magnetic energy storage /SMES/ unit for stabilizing an electric transmission system 22 p0237 A79-20555
- SCHERTZ, W. W.  
Nonimaging solar concentrators 21 p0043 A79-11973
- SCHIEFELBEIN, G. P.  
Chemical production from waste carbon monoxide: Its potential for energy conservation [BNWL-2137] 21 p0170 A79-10179
- SCHIMKE, G. R.  
Assessment of economic factors affecting the satellite power system. Volume 2: The systems implications of rectenna siting issues [NASA-CR-161186] 22 p0368 A79-21552
- SCHIMMEL, W. P., JR.  
Analysis and design of air heating unglazed flat plate solar collectors 22 p0280 A79-26202
- SCHLAIKER, C. R.  
Discharge reaction mechanisms in Li/SOCl<sub>2</sub> cells 22 p0305 A79-30331
- SCHLAPBACH, L.  
Localization and diffusion of hydrogen in lanthanum-nickel compounds 22 p0248 A79-21682  
Hydrides of rare earth-nickel compounds - Structure and formation enthalpies 22 p0250 A79-21697  
The plateau pressure of RE Ni<sub>5</sub> and RE Co<sub>5</sub> hydrides 22 p0250 A79-21698  
Hydrogen storage in FeTi - Surface segregation and its catalytic effect on hydrogenation and structural studies by means of neutron diffraction 22 p0312 A79-31156



- SCHLINGER, W. G.  
Gasification of coal liquefaction residues  
21 p0006 A79-10059
- SCHMID, B. K.  
SRC-II - Review of development and status  
21 p0092 A79-15887
- SCHMID, F.  
Silicon sheet growth development for the large  
area sheet task of the low cost solar array  
project. Heat exchanger method - ingot casting  
fixed abrasive method - multi-wire slicing  
[NASA-CR-158038] 21 p0219 A79-14540
- SCHMID, K. R.  
Weak points of our prediction models for raw  
materials strategy  
22 p0265 A79-24040
- SCHMIDT, D. A.  
A characteristic time correlation for combustion  
inefficiency from alternative fuels  
[AIAA PAPER 79-0357] 21 p0158 A79-19687
- SCHMITZ, H. W.  
Gasification of coal with high-temperature reactor  
heat - Investigations concerning the market and  
the economics  
22 p0264 A79-23828
- SCHMITZ, H.-H.  
Oil shale in the U.S. - Current state of  
technology and research  
22 p0265 A79-23830
- SCHNEIDER-HAUBERT, H.  
Energy development  
22 p0282 A79-26402
- SCHNEIDER, A. L.  
Liquefied natural gas safety research overview  
[AD-A063714] 22 p0365 A79-21233
- SCHNEIDER, J. C.  
Differential pressure measurements in high  
temperature environments  
21 p0144 A79-17599
- SCHNEIDER, K.  
Development and testing of the ULP solar array  
21 p0029 A79-10245
- SCHNEIDER, S. J.  
Materials  
21 p0106 A79-16491
- SCHNEIDER, T. R.  
Storage as an energy strategy for utilities  
21 p0093 A79-15891
- SCHOBERT, T.  
The iron-titanium - hydrogen system: A  
transmission electron microscope /TEM/ study  
22 p0285 A79-26947
- SCHOCK, H. W.  
Improvement of efficiency and stability by  
copper-treatment and front contacting of  
Cu/x/S-CdS solar cells  
21 p0123 A79-17345
- SCHOCK, H.-W.  
A pilot line for the production of large area  
Cu/x/S-CdS solar cells  
21 p0124 A79-17351
- SCHOENAU, G.  
The Saskatchewan Conservation House - Some  
preliminary performance results  
22 p0318 A79-31417
- SCHOENAU, G. J.  
Energy management through energy conservation in  
buildings  
22 p0320 A79-31431
- SCHORPP, K. F.  
The synergetics of the catalytic  
D-D-fusion-fission breeder  
22 p0252 A79-22236
- SCHOLL, M. M.  
Projecting energy resource utilization - The  
geothermal case  
21 p0068 A79-14321
- SCHOOLLEY, J. P.  
Temperature calibration for solar heating and  
cooling system evaluation  
21 p0089 A79-15846
- SCHREIBER, J. D.  
A copper oxide-copper sulfate water-splitting cycle  
21 p0015 A79-10128  
A hybrid thermochemical hydrogen production cycle  
using solar energy process heat  
[AIAA PAPER 78-1779] 21 p0062 A79-13874
- SCHROEDER, T. A.  
Oahu wind power survey  
[PB-287361/0] 22 p0335 A79-16382
- SCHUELER, D. G.  
Status of photovoltaic systems and applications  
21 p0095 A79-15907  
Status of the DOE photovoltaic concentrator  
technology development project  
[SAND-78-0948C] 21 p0176 A79-10550
- SCHULDT, R. L.  
Development of an Air Force facilities energy  
information system  
[AD-A059309] 21 p0223 A79-14918
- SCHULZE, W.  
Impacts of the National Energy Plan on solar  
economics  
[CONF-771203-6] 21 p0118 A79-17294
- SCHUMACHER, J. C.  
The production of solar cell grade silicon from  
bromosilanes  
[NASA-CR-158362] 22 p0358 A79-20482
- SCHUSTER, J. R.  
Design, construction, and testing of a Fixed  
Mirror Solar Concentrator field  
21 p0020 A79-10164  
Fixed mirror solar concentrator for power generation  
[GA-A-14883] 21 p0187 A79-11526
- SCHUSTER, O.  
Solar storage unit with built-in oil-gas boiler  
22 p0268 A79-24322
- SCHWAIGERER, W.  
Comparative outdoor measurements on flat-plate  
solar collectors in a metropolitan area in  
Western Germany  
21 p0128 A79-17394
- SCHWARTZ, B.  
A high-efficiency GaAs double-heterostructure  
photovoltaic detector  
21 p0154 A79-18489
- SCHWARTZ, S. R.  
Geothermal emissions data base: Cerro Prieto  
geothermal field  
[UCID-4033] 21 p0204 A79-13480  
A computerized reporting and monitoring system for  
geothermal energy development  
[LBL-8483] 22 p0369 A79-21555
- SCHWEIG, H.  
Evacuated solar flat-plate collectors for economic  
applications  
21 p0133 A79-17435
- SCHWEINBERG, R. M.  
Solar One - A 10-megawatt solar thermal central  
receiver pilot plant project  
[AIAA PAPER 78-1750] 21 p0060 A79-13853
- SCHWEITZER, J. K.  
Advanced industrial gas turbine cooling and high  
pressure compressor technology  
21 p0004 A79-10041
- SCHWENDINAN, L. C.  
Measured air flow rates through microorifices and  
flow prediction capability  
[PB-286868/5] 21 p0217 A79-14344
- SCHWENK, F. C.  
Gaseous fuel reactors for power systems  
[LA-UR-78-1437] 21 p0214 A79-13844
- SCHWERZEL, R. E.  
Methods for the photochemical utilization of solar  
energy  
21 p0111 A79-16641
- SCHWITZGERBEL, K.  
Trace element emissions from coal-fired power plants  
[ASME PAPER 78-WA/FU-9] 21 p0160 A79-19789
- SCINTA, J.  
Catalytic hydrodesulfurization and liquefaction of  
coal - Batch autoclave studies  
22 p0282 A79-26465
- SCOTT, C. J.  
Heat transfer - A review of 1977 literature  
21 p0155 A79-18973
- SCOTT, D. R.  
Solar tracking control system Sun Chaser  
[NASA-TN-78199] 21 p0172 A79-10514
- SCOTT, G. C.  
Energy scenarios: Supplementary studies  
[NP-23292] 21 p0211 A79-13543
- SCOTT, R. J.  
Technology considerations in the design of a  
commercial offshore energy conversion /OTEC/ plant  
22 p0288 A79-27378

- SCOTT, R. L.  
Ambient air quality assessment of the Synthane  
coal gasification pilot plant, six month study  
/August 1976-January 1977/ 21 p0064 A79-14113
- SCOTT, T. C.  
Solar system modeling using a modular approach  
with generalized programs for working fluid  
properties 22 p0266 A79-24310
- SCOVILLE, A. E.  
Acceleration of solar heating application via  
improved data evaluation 21 p0087 A79-15829
- SCROSATI, B.  
Silver selenate and silver tellurate as positive  
materials for lithium primary power sources 22 p0245 A79-21484
- SCUDIERRE, J. D.  
Conductor for LASL 10-MWhr superconducting energy  
storage coil 21 p0085 A79-15309
- SEAMONS, L. O.  
The USA 5MW solar thermal test facility 21 p0135 A79-17449  
1MW calorimetric receiver for Solar Thermal Test  
Facility [ASME PAPER 78-WA/SOL-7] 21 p0163 A79-19839  
Solar thermal test facility experiment manual  
[SAND-77-1173] 21 p0221 N79-14568
- SEARLES, B.  
Oil pollution reports, volume 5, number 2  
[PB-287071/5] 22 p0336 N79-16437
- SEBASTIANI, G.  
Energy from sea waves - System optimization by  
diffraction theory 22 p0288 A79-27390
- SECHRIST, D.  
Solar-earth homes and cities 21 p0098 A79-16105
- SEDIK, M. V.  
Analysis of the characteristics of silicon  
photoconverters in the 100-400 K temperature range  
21 p0167 A79-20361
- SEELY, F. G.  
New processes for the recovery of resource  
materials from coal combustion wastes 21 p0007 A79-10065
- SEETHARAMU, K. R.  
Liquid solar collector 21 p0133 A79-17433
- SEGR, H.  
Modeling two-phase flow in a swirl combustor 22 p0280 A79-26189
- SEIDEL, R. C.  
Power train analysis for the DOE/NASA 100-kW wind  
turbine generator [NASA-TN-78997] 22 p0333 N79-16355
- SEIDENSTICKER, B. G.  
Silicon web process development [NASA-CR-158376] 22 p0357 N79-20282
- SEIPERT, P.  
Investigation of the heat transfer in cylindrical  
receiver configurations with inner tubes  
[ASME PAPER 79-GT-64] 22 p0306 A79-30532
- SEIKEL, G. R.  
Preliminary summary of the ETP conceptual studies  
[NASA-TN-78999] 21 p0183 N79-11478  
Evaluation of the ECAS open cycle MHD power plant  
design [NASA-TN-79012] 22 p0341 N79-17335
- SEILER, A.  
The plateau pressure of RE Ni5 and RE Co5 hydrides 22 p0250 A79-21698
- SEITZ, H.  
Total energy systems 21 p0058 A79-13654
- SEKHAR, K. C.  
Combustion of hydrothermally treated coals  
[PB-287521/9] 22 p0338 N79-17025
- SEKHAR, R.  
Modification of electrostatic precipitator  
performance by use of fly-ash conditioning agents  
[ASME PAPER 78-WA/APC-3] 21 p0158 A79-19736
- SEKI, M.  
The fouling of the wall stabilization problem  
of an axisymmetrical toroidal sharp-boundary  
plasma with a horizontally elongated noncircular  
cross section 22 p0327 A79-32103
- SEKIOKA, M.  
Infrared remote sensing on geothermal areas by  
helicopter 22 p0256 A79-22620
- SEKIYA, T.  
Simultaneous nitrogen oxides and sulfur dioxide  
removal by absorption-reduction scrubbing 21 p0066 A79-14125
- SELCOCK, M. K.  
A graphical approach to the efficiency of  
flat-plate collectors 21 p0102 A79-16422  
Solar collectors. I - Fundamentals and collectors  
of the past and present 21 p0103 A79-16455  
Solar thermal conversion 21 p0104 A79-16466  
Non-tracking solar energy collector system  
[NASA-CASE-NPO-13817-1] 21 p0182 N79-11471  
A fixed tilt solar collector employing reversible  
vee-through reflectors and evaluated tube  
receivers for solar heating and cooling systems  
[NASA-CR-158420] 22 p0359 N79-20490  
An improved solar energy receiver for a stirling  
engine [NASA-CASE-NPO-14619-1] 22 p0362 N79-20513
- SELF, S. A.  
Plasma diagnostics in an MHD installation 21 p0106 A79-16492
- SELIN, K. I.  
Energy sources and conventional magnets 21 p0079 A79-14791
- SELHAN, J. R.  
Partial processes and transport parameters in  
molten carbonate fuel cell operation 21 p0040 A79-11819
- SELWYN, S.  
The use of ocean energy - A hydrostatic motor 22 p0288 A79-27391
- SEMAN, E. J.  
Phase two of the array automated assembly task for  
the low cost solar array project [NASA-CR-158359] 22 p0359 N79-20484
- SEMEHA, M. G.  
Investigation of the thermophysical  
characteristics of cryogenic heat pipes with a  
metal-fiber wick 22 p0288 A79-27529
- SEMEROV, V. D.  
U-25B MHD unit for carrying out investigations  
under the conditions of strong electric and  
magnetic fields 21 p0049 A79-12692  
Channel No. 1 of the MHD generator of a U-25B unit  
for carrying out investigations in strong  
electric and magnetic fields 21 p0049 A79-12693
- SEMO, M.  
Useful power from ocean waves 21 p0077 A79-14773
- SEN, A.  
Metropolitan work-trip energy consumption patterns 22 p0299 A79-29335
- SENS, A. P. C.  
Experimental investigation on the discharge  
structure in a noble gas MHD generator  
[TH-78-E-79] 22 p035C N79-18758
- SENS, W.  
Advanced turbofan engines for low fuel consumption  
[ASME PAPER 78-GT-192] 21 p0033 A79-10816
- SENS, W. H.  
Engine component improvement and performance  
retention 21 p0202 N79-13198  
Low energy consumption engines 21 p0202 N79-13199
- SERAPHIN, B. O.  
Chemical vapor deposited molybdenum films for use  
in photothermal conversion 22 p0294 A79-28148  
Chemical vapor deposited amorphous silicon for use  
in photothermal conversion 22 p0294 A79-28149

- New instrumentation for high temperature and hemispherical measurements of selective surfaces  
22 p0294 A79-28152
- SEREDENKO, E. V.  
Dynamic stabilization of toroidal discharges in weak longitudinal magnetic fields  
22 p0324 A79-31766
- SERGISON, J.  
Development and application of techniques to evaluate cogeneration impacts  
22 p0303 A79-29795
- SERTH, R. W.  
Energy requirements of present pollution control technology  
[PB-286231/6] 21 p0223 N79-14643
- SERVAIS, R. A.  
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- SETEANU, I.  
Optimal decisions for long-term operation of hydropower systems  
22 p0245 A79-21473
- SETH, A. K.  
Periodic heating/cooling by solar radiation  
21 p0140 A79-17491
- SEVERN, B.  
Prefabricated caissons for tidal power development  
21 p0152 A79-18113
- SEXTON, P. W.  
Compilation of level 1 environmental assessment data  
[PB-286924/6] 22 p0336 N79-16439
- SEYFERT, P.  
Conceptual design of a superconducting tokamak - 'TORUS II SUPRA'  
22 p0236 A79-20543
- SFORZA, P. M.  
Wind turbine generator wakes  
[AIAA PAPER 79-0113] 21 p0156 A79-19539  
Wind power distribution, control, and conversion in vortex augmentors  
22 p0278 A79-26180
- SHAFPER, L. H.  
Viscosity stabilized solar ponds  
21 p0133 A79-17430
- SHAPRANOV, V. D.  
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21 p0069 A79-14454
- SHAH, Y. M.  
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[PB-281271/7] 21 p0178 N79-10591
- SHAI, I.  
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21 p0027 A79-10228  
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21 p0027 A79-10229
- SHAKHBAZOV, SH. D.  
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21 p0167 A79-20360
- SHAKHPARONIAN, V. V.  
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21 p0167 A79-20359
- SHALTIEL, D.  
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22 p0250 A79-21702
- SHAMS, A.  
Economic optimization of heatpump assisted solar heating in Illinois  
21 p0072 A79-14691
- SHAMSUNDAR, B.  
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22 p0281 A79-26207
- SHAWER, W. W.  
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21 p0046 A79-12273  
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22 p0263 A79-23758
- SHANKAR, D.  
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21 p0122 A79-17337
- SHANKLIN, R. V.  
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21 p0016 A79-10136  
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[AIAA PAPER 79-0188] 21 p0157 A79-19587
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[ASME PAPER 78-WA/APC-2] 21 p0158 A79-19735
- SHANNON, R. E.  
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[NASA-CR-161200] 22 p0360 N79-20499
- SHANTHI, E.  
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21 p0124 A79-17350
- SHAPIRO, H. H.  
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22 p0319 A79-31423  
Validation of an electric circuit model of a solar house  
22 p0321 A79-31440
- SHAPIRO, P. S.  
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[PB-286550/9] 21 p0232 N79-15868
- SHARAN, R.  
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21 p0125 A79-17360
- SHARAN, S. G.  
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21 p0126 A79-17371
- SHARMA, G. K.  
Performance of a honeycomb type flat plate collector with serpentine tube  
21 p0054 A79-13579
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- SHARP, L. E.  
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21 p0070 A79-14459
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- SHCHUKIN, V. K.  
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- SHH, C. Y.  
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- SHEALY, D. L.  
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- SHEARER, D. M.  
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- SHEARER, J.  
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- SHEERIN, P.  
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- SHEPT, I.  
Absorption of hydrogen by the intermetallics NdNi5 and LaNi4Cu and a correlation of cell volumes and desorption pressures 21 p0038 A79-11804  
HYCSOS - A system for evaluation of hydrides as chemical heat pumps 22 p0252 A79-21716
- SHEINDLIN, A. E.  
U-25B MHD unit for carrying out investigations under the conditions of strong electric and magnetic fields 21 p0049 A79-12692
- SHEKOTAN, M. G.  
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- SHELLEY, T. R.  
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- SHELTON, S. V.  
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[GA-A-14883] 21 p0187 N79-11526
- SHEN, C. N.  
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- SHEN, M.-S.  
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- SHENOY, S. U.  
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- SHEPARD, M. F., JR.  
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- SHEPHERD, E. M.  
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- SHERCLIFF, J. A.  
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- SHERIDAN, J. C.  
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- SHERWOOD, W. G.  
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[NASA-TN-79023] 21 p0226 N79-15267
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Optimization of the flow passage geometry for air heating solar collectors 22 p0316 A79-31403  
Optimization studies on black chrome electroplating variables for solar selective surfaces 22 p0317 A79-31407  
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[PB-283028/9] 21 p0178 N79-10595
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- SHILIN, O. V.  
Problems in the development of high-service-life capacitative accumulators 22 p0243 A79-21249
- SHIMADA, K.  
Prospects of thermionic power systems 21 p0026 A79-10220
- SHIMADA, R.  
Flywheel energy storage system for JT-60 toroidal field coil 21 p0112 A79-16729
- SHINOTAKE, H.  
Advances in the development of lithium-aluminum/metal sulfide cells for electric-vehicle batteries 21 p0010 A79-10089
- SHINSHOCK, R. P.  
New instrumentation for high temperature and hemispherical measurements of selective surfaces 22 p0294 A79-28152
- SHINAR, J.  
Hydrogen sorption properties in binary and pseudobinary intermetallic compounds 22 p0250 A79-21702
- SHINDE, A. S.  
Performance of a honeycomb type flat plate collector with serpentine tube 21 p0054 A79-13579
- SHINTONI, T.  
Superconducting energy storage magnets 22 p0236 A79-20537
- SHIODA, S.  
Experimental studies of a linear MHD generator with fully ionized seed 22 p0238 A79-20796  
MHD gas turbine energy conversion for mirror fusion reactors 22 p0313 A79-31192

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Ga/1-x/Al/x/As-GaAs photovoltaic cells with  
multilayer structure 22 p0305 A79-30258
- SHIRAI, H.  
A new combustion system in the three-valve  
stratified charge engine  
[SAE PAPER 790439] 22 p0316 A79-31376
- SHIRATORI, E.  
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- SHIROGAMI, T.  
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- SHISHKO, A. A.  
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low-density plasma 22 p0244 A79-21432
- SHITZER, A.  
Experiments with a flat plate solar water heating  
system in thermosyphonic flow 22 p0262 A79-23755
- SHIWALKAR, B. D.  
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- SHORE, C. P.  
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- SHORT, H. E.  
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- SHPIGEL, I. S.  
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lifetime in ohmic heating in the L-2 stellarator  
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[AIAA PAPER 78-1774] 21 p0062 A79-13871
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generation 21 p0104 A79-16478  
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- SHURTLEFF, W. W.  
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- SHUSTER, C. H., JR.  
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22 p0318 A79-31420
- SIBBITT, B. E.  
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the NRC 14 house solar demonstration program  
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- SIBBITT, W. L.  
Thermal conductivity of crystalline rocks  
associated with energy extraction for hot dry  
rock geothermal systems 22 p0304 A79-30123
- SIDLE, R. C.  
Potential agricultural uses of fluidized bed  
combustion waste 21 p0064 A79-14108
- SIDOROV, V. S.  
U-25E MHD unit for carrying out investigations  
under the conditions of strong electric and  
magnetic fields 21 p0049 A79-12692
- SIEBELS, J.  
Development of multi-density silicon nitride  
turbine rotors 21 p0050 A79-12832
- SIEBERS, D. L.  
Some aspects of the transient response of a  
flat-plate solar energy collector 21 p0153 A79-18466
- SIEBMANNS, W.  
Development of ceramic parts for a truck gas  
turbine at MTU 21 p0050 A79-12831
- SIEGEL, B.  
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photovoltaic utility applications through a user  
subsidy 21 p0061 A79-13866  
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[NASA-TN-79031] 21 p0194 A79-12086
- SIPPERT, P.  
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barriers and MIS solar cells 21 p0123 A79-17342
- SIGALOV, IU. E.  
Production and application of rolling-welded  
aluminum alloy panels for solar water heaters  
for hot water and cooling systems 22 p0297 A79-28670
- SIGL, A. B.  
Run duration analysis of surface wind speeds for  
wind energy application 22 p0287 A79-27345  
Stochastic analysis of wind characteristics for  
energy conversion 22 p0350 A79-18535
- SIKRI, A. P.  
Status of the DOE underground coal conversion  
program 21 p0005 A79-10052
- SILBERMAN, D.  
Chemical studies of stack fly ash from a  
coal-fired power plant 22 p0309 A79-30595
- SILLESEN, A. E.  
Plasma density measurements on refuelling by solid  
hydrogen pellets in a rotating plasma 22 p0255 A79-22369
- SILVERMAN, J.  
Coal conversion by flash hydrolysis and  
hydrogasification 21 p0006 A79-10055
- SILVESTON, P. L.  
Use of monolithic structures for the short term  
storage of solar energy 21 p0121 A79-17327
- SILVESTRI, A. J.  
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synthesis gas to hydrocarbons 21 p0007 A79-10064

- SILVESTRI, V.  
Selective covers for natural cooling devices  
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- SIMMONS, G.  
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and assessment  
[PB-290173/4] 22 p0367 A79-21530
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- SIMMS, R. J.  
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21 p0085 A79-15334  
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- SINOH, H.  
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21 p0057 A79-13644
- SIMONS, S. N.  
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parametric analysis of a residential complex  
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- SIMONSEN, B. H.  
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- SINCLAIR, T. J.  
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- SINEATH, B. H.  
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- SINGAL, C. N.  
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21 p0136 A79-17455
- SINGH, J. J.  
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- SINGH, P.  
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21 p0128 A79-17388  
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cylindrical parabolic concentrator and a  
flat-plate collector  
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- SINHA, J. P.  
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engine  
[SAE PAPER 790438] 22 p0315 A79-31375
- SIBAZIDINOV, T. K.  
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a variety of products  
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- SITNOV, V. I.  
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- SKELTON, A.  
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- SKIBENKO, B. I.  
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thermonuclear synthesis  
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sodium/beta-alumina/SbCl<sub>3</sub> cells  
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reservoir rock  
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generation  
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- SMITH, A. K.  
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System mechanization  
[PB-282654/3] 21 p0177 N79-10557  
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Life-cycle costs  
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Vehicle tests  
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Fuels flexibility  
[ASME PAPER 79-GT-72] 22 p0307 A79-30536
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- SMITH, G.  
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- SMITH, M. Y.  
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- SMITH, N.  
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22 p0296 A79-28438
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- STEINHART, J. S.  
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- STEITZ, P.  
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- STINE, G. H.  
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[AAS PAPER 78-144] 22 p0243 A79-21259
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- STIRN, R. J.  
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- STONEKING, J. E.  
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- STOUT, W. L.  
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- STRABO, F.  
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21 p0125 A79-17358
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- STREED, E. R.  
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[PB-288630/7] 22 p0352 A79-19173
- STRICKLAND, L. D.  
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- STRINGER, J.  
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- STROBEL, G. L.  
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- STROM, S. S.  
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- STROTHER, L. W.  
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22 p0312 A79-31156
- STUHLINGER, E.  
Electric automobiles - Yes  
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- STULTZ, J. W.  
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[NASA-CR-158174] 22 p0354 A79-19460
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[AAS PAPER 78-144] 22 p0243 A79-21259
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21 p0050 A79-12826
- STYRIS, D. L.  
Solar pond stability experiments  
21 p0042 A79-11878
- SUCKLING, P. W.  
On the use of synoptic weather map typing to define solar radiation regimes  
22 p0272 A79-25392
- SUDA, S.  
Mixing effects of two different types of hydrides  
22 p0251 A79-21714
- SUDAN, R. B.  
Generation and applications of high power ion beams to fusion research  
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21 p0010 A79-10088
- SUESER, K.  
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[AIAA 79-0733] 22 p0298 A79-29007  
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21 p0067 A79-14289  
Structural performance of the DOE/Sandia 17 meter vertical axis wind turbine  
[SAND-78-0880C] 21 p0187 A79-11516
- SULZMAN, K. G. P.  
Shock-tube measurements of induction and post-induction rates for low-Btu gas mixtures  
21 p0083 A79-15245
- SUNARIA, V. H.  
Preliminary controller evaluation for the MERC/CTIO using a mathematical process model  
21 p0008 A79-10073
- SUNNERS, R. A.  
Energy and remote sensing applications  
22 p0255 A79-22516
- SUN, K.  
Laser aircraft propulsion  
21 p0109 A79-16618  
Laser aircraft  
22 p0284 A79-26597
- SUN, T. H.  
Analysis and application of the heat pipe heat exchanger  
21 p0014 A79-10117  
The analysis of heat transfer with and without condensation in a heat pipe heat exchanger  
[ASME PAPER 78-WA/HT-59] 21 p0161 A79-19824
- SUPERZYNSKI, M. J.  
Heat pulses required to quench a potted superconducting magnet  
22 p0236 A79-20538
- SUREK, T.  
Large area silicon sheet by EPG  
21 p0123 A79-17340
- SURI, R. K.  
Return flow solar air-heater  
21 p0055 A79-13609  
Development of small solar power plants for rural areas in India  
21 p0141 A79-17502
- SURPRENANT, J. K.  
A lithium/dissolved sulfur battery with an organic electrolyte  
22 p0305 A79-30332
- SUTCLIFFE, P.  
Prospects for improvements in lead-acid batteries  
22 p0300 A79-29488
- SUTER, P.  
Study of solid-gas-suspensions used for direct absorption of concentrated solar radiation  
22 p0262 A79-23757
- SUTTER, S. L.  
Measured air flow rates through microorifices and flow prediction capability  
[PB-286868/5] 21 p0217 A79-14344
- SUTTON, P. D.  
Structural cost optimization of photovoltaic central power station modules and support structure  
[ASME PAPER 79-SOL-17] 22 p0309 A79-30551
- SUWAL, G.  
Comparison of nuclear and coal power plants using Net Energy Analysis  
21 p0073 A79-14692

- SVATA, H.**  
Influence of composition on the activity of tungsten carbide gas diffusion hydrogen electrodes  
22 p0245 A79-21482
- SVISHCHEV, V. S.**  
Experiments on controlling the plasma density in the TO-1 tokamak  
22 p0324 A79-31762
- STOBODA, J. V.**  
Digital or analog modelling in the design of hydrostatic vehicular systems  
22 p0264 A79-23808  
Optimization of a novel hydrostatic drive performance using hybrid computing technique  
22 p0264 A79-23809
- SWAINE, D. J.**  
The fate of trace elements in coal after combustion  
21 p0116 A79-17250
- SWALES, H. C.**  
Review of optimization and economic evaluation of potential tidal power developments in the Bay of Fundy  
21 p0152 A79-18111
- SWALLOM, D.**  
Subsonic diffusers for MHD generators  
22 p0279 A79-26185
- SWALLOM, D. W.**  
Magnetohydrodynamic lightweight channel development [AD-A060429]  
21 p0230 N79-15414
- SWARTY, H. H. S.**  
Efficient use of wind energy by using static slip recovery systems - A simulator study  
21 p0113 A79-16744
- SWANSON, R. H.**  
A proposed thermophotovoltaic solar energy conversion system  
22 p0287 A79-27317
- SWARTMAN, R. K.**  
An ocean thermal difference power plant in the Canadian Arctic  
22 p0318 A79-31415
- SWEET, L. H.**  
Optimal control of on-board and station flywheel storage for rail transit systems  
21 p0148 A79-17822  
Optimal control of on-board and station flywheel storage for rail transit systems [ASME PAPER 78-WA/DSC-32]  
21 p0159 A79-19771
- SWERDLING, H.**  
The application of solar thermoelectric generators in near-sun missions  
21 p0023 A79-10187  
Design concepts of solar thermoelectric generators in space applications  
22 p0260 A79-23612
- SWET, C. J.**  
Energy storage requirements for autonomous and hybrid solar thermal electric power plants  
21 p0120 A79-17315
- SWIFT, J. L.**  
Air quality impacts using SRC versus conventional coal in power plants [PB-290237/7]  
22 p0373 N79-21671
- SWISSHELM, B. A.**  
A mass and energy balance of a Wellman-Galusha gasifier  
22 p0283 A79-26467
- SWITZENBAUM, H. S.**  
The anaerobic attached film expanded bed reactor for the treatment of dilute organic wastes  
22 p0356 N79-19928
- SYLVESTER, J. R.**  
Thyristor controlled rectifier inverting at unity power factor  
21 p0033 A79-10898
- SYLWAN, C.**  
Utility fuel cells for biomass fuel  
21 p0016 A79-10131
- SYMONDS, R. A.**  
Environmental assessment for residual oil utilization [PB-286982/4]  
22 p0336 N79-16446
- SYMONS, J. G.**  
Thermal performance testing of flat-plate solar collectors  
21 p0130 A79-17407
- SYMONS, P. C.**  
100Mwh zinc-chlorine peak-shaving battery plants  
21 p0011 A79-10096
- SZETELA, R. J.**  
Analytical evaluation of the impact of broad specification fuels on high bypass turbofan engine combustors [NASA-CR-159454]  
21 p0200 N79-13050
- T**
- TABOR, H.**  
Status report on selective surfaces  
21 p0126 A79-17374
- TAGER, S. A.**  
Fuels and combustion  
21 p0106 A79-16488
- TAKHOV, B. D.**  
The feasibility of constructing a photoelectric unit utilizing effluent heat  
21 p0125 A79-17358
- TAKAHASHI, K.**  
Series resistance effects in GaIn/As/GaAs concentrator solar cells  
22 p0273 A79-25745
- TAKAHASHI, P. K.**  
Solar and wind energy applications in Hawaii  
21 p0066 A79-14265
- TAKANO, H.**  
Flywheel energy storage system for JT-60 toroidal field coil  
21 p0112 A79-16729
- TAKETANI, H.**  
Specular mirrors for solar energy application  
21 p0034 A79-11147
- TALANOVA, V. D.**  
Contribution to the theory of the pulsed mode of operation of the thermionic energy converter. II  
22 p0246 A79-21542
- TALBERT, S. G.**  
The development of a 37 kW solar-powered irrigation system  
21 p0144 A79-17525
- TALBERT, W.**  
Large, lightweight, replicated mirrors  
21 p0043 A79-11976
- TALBERT, W. H.**  
Second-generation integrated coal gasification/combined-cycle power systems [ASME PAPER 78-GT-14]  
21 p0032 A79-10778
- TALBOT, J. E.**  
Powerplant integration - The application of current experience to future developments [ASME PAPER 78-GT-113]  
21 p0032 A79-10788
- TALIB, A.**  
Alternative forms of energy transmission from OTEC plants  
21 p0141 A79-17505
- TANOH, S.**  
Interpretation of cyclotron radiation spectra from runaway discharges in TFR  
22 p0313 A79-31185
- TANURA, S.**  
Flywheel energy storage system for JT-60 toroidal field coil  
21 p0112 A79-16729
- TAN, K. J.**  
Solar radiation studies for utilization of flat-plate collectors in an equatorial region  
21 p0119 A79-17311
- TANAKA, S.**  
Hydrogen storage by LaNi5 - Fundamentals and applications  
21 p0038 A79-11803  
Electron cyclotron heating in high density toroidal plasmas  
22 p0265 A79-24037
- TANAKA, T.**  
Solar thermal energy storage using heat of dilution - Analysis of heat generation in multistage mixing column  
21 p0046 A79-12271  
Estimation of collector and electrical energy cost for STEPS in Japan  
21 p0118 A79-17288  
An analysis of a cylindrical parabolic focussing collector for distributed collector power system  
21 p0134 A79-17442
- TANEMURA, S.**  
The testing procedures of thermal performance of solar collector at Solar Research Lab., G.I.R.I.  
21 p0130 A79-17409

- TANI, T.**  
Solar thermal energy storage using heat of dilution - Analysis of heat generation in multistage mixing column 21 p0046 A79-12271  
Estimation of collector and electrical energy cost for STEPS in Japan 21 p0118 A79-17288  
An analysis of a cylindrical parabolic focussing collector for distributed collector power system 21 p0134 A79-17442
- TANK, E.**  
Designing and testing Si<sub>3</sub>N<sub>4</sub> turbine components at Mercedes-Benz 21 p0050 A79-12830
- TANNER, C. E.**  
Remote monitoring of coal strip mine rehabilitation [PB-286647/3] 21 p0228 A79-15379
- TANNER, D. P.**  
Silicon solar cell process development, fabrication and analysis [NASA-CR-158363] 22 p0359 A79-20485
- TANNER, R. G.**  
Selection of optimum sites for tidal power development in the Bay of Fundy 21 p0152 A79-18110
- TAPLIN, D. M. R.**  
Fracture research in Canada 21 p0144 A79-17530
- TARNAN, P. B.**  
Hydrogen via gasification - Today and tomorrow 22 p0289 A79-27652
- TARNIZHEVSKII, B. V.**  
Facility with sectioned photoreceiver and laser radiator for determining solar radiation concentrator accuracy characteristics 21 p0054 A79-13292  
Experimental investigation of the joint operation of wind and solar plants 21 p0167 A79-20358
- TARR, E. G.**  
An investigation of dark current and photocurrent superposition in photovoltaic devices 22 p0291 A79-27871
- TASCHER, W. G.**  
High energy metal hydride fuel cell power source [AD-A056491] 21 p0184 A79-11485
- TASDEMIROGLU, E.**  
Calculation of solar energy incident on non-horizontal surfaces over Turkey 22 p0253 A79-22266
- TASSICKER, O. J.**  
Advanced emissions control and test facility of the Electric Power Research Institute 21 p0115 A79-17249
- TAUNTON, J. W.**  
Exxon Donor Solvent coal liquefaction process development 21 p0007 A79-10060  
Status and outlook of the Exxon Donor Solvent coal liquefaction process development 21 p0092 A79-15889
- TAUSSIG, R. T.**  
Energy exchanger technology applied to laser heated engines 21 p0110 A79-16631
- TAVANA, H.**  
A computerized reporting and monitoring system for geothermal energy development [LBL-8483] 22 p0369 A79-21555
- TAVGER, M. D.**  
Selection of a characteristic quantity defining the self-ignition of a fuel in a stream 21 p0114 A79-16786
- TAYLOR, E. J.**  
New alloy systems for hydrogen storage 21 p0038 A79-11806
- TAYLOR, R. E.**  
A microprocessor monitoring system for a solar energy installation 21 p0088 A79-15840
- TAYLOR, L. E.**  
Design problems of air source solar boosted heat pumps 21 p0138 A79-17472
- TCHERNEV, D. I.**  
Solar energy application of natural zeolites 22 p0286 A79-27213
- TEARE, J. D.**  
The MHD interaction and plasma properties in a shock tube driven disk generator with swirl 21 p0083 A79-15260
- TEETER, R. E.**  
Earth orbital assessment of solar electric and solar sail propulsion systems [NASA-CR-158167] 22 p0345 A79-17898
- TEGGEES, H.**  
Substitute natural gas from coal using high-temperature reactor heat - Project 'Prototype Plant Nuclear Process Heat' 22 p0264 A79-23827
- TELEGIN, G. P.**  
Materials 21 p0106 A79-16491
- TENKIN, B. J.**  
Characteristics of electron-cyclotron-resonance-heated tokamak power reactors 22 p0292 A79-27885
- TEMPLEMEYER, K. E.**  
Status of the U.S./U.S.S.R. cooperative program for the development of open-cycle MHD power generators 22 p0290 A79-27661  
MHD balance of plant technology project [ANL-MHD-78-7] 22 p0361 A79-20500
- TEMPLIN, R. J.**  
NRC's wind energy program 22 p0319 A79-31426
- TROFILO, V. L.**  
Perspective on the fusion-fission energy concept 21 p0095 A79-15913
- TEPPER, H.**  
Alternatives for coal based power generation - An international overview 21 p0008 A79-10074
- TERDAN, P. P.**  
Power management and control for space systems 21 p0170 A79-10134
- TEREN, Y.**  
An economical approach to space power systems 21 p0170 A79-10139
- TERESHIN, V. D.**  
The feasibility of constructing a photoelectric unit utilizing effluent heat 21 p0125 A79-17358
- TERMAIN, P. A.**  
Late diagenetic indicators of buried oil and gas. 2: Direct detection experiment at Cement and Garza fields, Oklahoma and Texas, using enhanced LANDSAT 1 and 2 images [E79-10099] 22 p0347 A79-18373
- TERNAN, B.**  
Coke formation on hydrosulphurization catalysts 22 p0283 A79-26470
- TERRY, J. L.**  
The effects of wall temperature on light impurities in Alcator 22 p0313 A79-31188
- TERUNICHI, I.**  
Electron cyclotron heating in high density toroidal plasmas 22 p0265 A79-24037
- TESSNER, R. G., JR.**  
Methodology for modeling geothermal district heating for residential markets [BNL-50905] 22 p0361 A79-20502  
Economic impacts of a transition to higher oil prices [BNL-50871] 22 p0364 A79-20927
- TESTER, J. W.**  
Mining earth's heat - Hot dry rock geothermal energy 22 p0258 A79-23280  
Thermal conductivity of crystalline rocks associated with energy extraction for hot dry rock geothermal systems 22 p0304 A79-30123
- TETZLAFF, G.**  
Power extracted from the wind 21 p0058 A79-13650
- TEW, R. C., JR.**  
Initial comparison of single cylinder Stirling engine computer model predictions with test results [SAE PAPER 790327] 22 p0315 A79-31368

PERSONAL AUTHOR INDEX

THYAGARAJAN, K.

- Initial comparison of single cylinder Stirling engine computer model predictions with test results  
[NASA-TM-79044] 22 p0337 879-16721
- TEWARI, S. K.  
A methodology for evaluating the worth of a new energy resource with particular reference to wind energy utilisation in rural areas 21 p0143 879-17514  
An evaluation of the strategy of low cost horizontal axis windmills 21 p0143 879-17517
- TEWARY, V. K.  
Response of a solar cell to intense and nonuniform illumination when used with solar concentrators 21 p0125 879-17357  
A report on the various heat collection and heat storage systems evolved under the solar energy programme at B. I. T. S. 21 p0132 879-17423
- THACHER, E. P.  
Verification of wedge concentration using a helium neon laser 21 p0098 879-16104  
Some effects of leg surface heat losses on the performance of a p-n type thermoelectric generator 22 p0260 879-23616
- THALHAMMER, E. D.  
Real time computer control of 5 megawatts of solar thermal energy 21 p0144 879-17621
- THANUPURAN, M. K. V. V.  
Sensitivity calculations for the design of solar cells. I - Schottky barrier devices 21 p0125 879-17360
- THEODORE, L.  
Energy and the environment; Proceedings of the Fifth National Conference, Cincinnati, Ohio, November 1-3, 1977 21 p0063 879-14106
- THIAGARAJAN, V.  
The ion fly-wheel effect on the electro-thermal instability in non-equilibrium MHD Hall disc generators 21 p0046 879-12270  
A collisional plasma rotating between two cylinders 21 p0049 879-12694
- THIELE, C. L.  
Thermal energy transformer [NASA-CASE-WFO-14058-1] 22 p0348 879-18443
- THIENE, L. G.  
Initial comparison of single cylinder Stirling engine computer model predictions with test results [SAE PAPER 790327] 22 p0315 879-31368  
Initial comparison of single cylinder Stirling engine computer model predictions with test results [NASA-TM-79044] 22 p0337 879-16721
- THOMAS, G. C.  
A small horizontal axis wind turbine feeding power into the utility grid 21 p0074 879-14703
- THOMAS, C. L.  
The effect of limiters and current profile on elliptic free-boundary MHD equilibria 22 p0291 879-27881
- THOMAS, J. P. S.  
The performance of the heating system in the solar house of the Eindhoven University of Technology 22 p0276 879-25938
- THOMAS, R. B.  
Solar heating for a novel dwelling independent of servicing networks 21 p0140 879-17492  
Wind generation of electricity for a novel dwelling independent of servicing networks 21 p0142 879-17513
- THOMAS, R. G.  
Assessment of economic factors affecting the satellite power system. Volume 2: The systems implications of rectenna siting issues [NASA-CR-161186] 22 p0368 879-21552
- THOMAS, R. K.  
High-current power leads for tokamak fusion reactor superconducting magnets 21 p0085 879-15318
- THOMAS, R. L.  
Large wind turbine generators 21 p0092 879-15881
- THOMAS, W. C.  
Modeling, simulation, testing, and measurements for solar energy systems; Proceedings of the Winter Annual Meeting, San Francisco, Calif., December 10-15, 1978 22 p0266 879-24309  
Effects of test fluid, flow rate, and flow regime on solar collector thermal performance measurements 22 p0268 879-24317  
Results and analysis of a round robin test program for liquid-heating flat-plate solar collectors 22 p0295 879-28356  
Guidelines for preparing environmental test plans for coal gasification plants [PB-286659/8] 21 p0232 879-15479
- THOMASSEN, K. I.  
The Mirror Fusion Test Facility /MPTF/ 21 p0018 879-10147
- THOMAS, B. J.  
Design study of superconducting magnets for a combustion magnetohydrodynamic /MHD/ generator 21 p0084 879-15305  
Fabrication and assembly considerations for a base load MHD superconducting magnet system 22 p0235 879-20534
- THOMPSON, E.  
Development of energetic neutral beams to the megawatt power level for controlled thermonuclear research 21 p0054 879-13439
- THOMPSON, K. P.  
Optical design of a solar collector for the advanced solar thermal electric conversion/process heat program [V/SUB-77/14261] 21 p0209 879-13528
- THOMPSON, H. J.  
Oahu wind power survey [PB-287361/0] 22 p0335 879-16382
- THOMPSON, P. B.  
The role of the Large Coil Program in the development of superconducting magnets for fusion reactors 22 p0236 879-20541
- THOMPSON, T. L.  
The ClearView Solar Collector system and associated one and two stage evaporative cooling - Interim results [AIAA PAPER 78-1759] 21 p0061 879-13860
- THOMSON, J. J.  
Stimulated Raman scatter in laser fusion target chambers 21 p0155 879-18794
- THOMSON, S. W.  
Thomson Solar House I 22 p0276 879-25936
- THOMSON, W. B.  
A 5-GWe nuclear satellite power system conceptual design 21 p0003 879-10033
- THORLEY, G. A.  
Current and potential uses of aerospace technology by the U.S. Department of the Interior [AIAA PAPER 78-1716] 21 p0060 879-13833
- THORNESJO, B.  
A low energy scenario for the United States - 1975-2050 21 p0147 879-17649
- THORNTON, M. W.  
Oil recovery from a Utah tar sand deposit by in situ combustion 21 p0004 879-10043
- THORNGHORTON, J.  
Air quality assessment of particulate emissions from diesel-powered vehicles [PB-286172/2] 21 p0223 879-14641
- THURLOW, G. G.  
Investigation of the corrosion performance of boiler, air heater, and gas turbine alloys in fluidized combustion systems 21 p0080 879-14931
- THYAGARAJAN, K.  
Performance of solar concentrators - A theoretical study 21 p0135 879-17453

- TIEB, H. T.**  
The photogalvanovoltaic cell  
21 p0066 A79-14264
- TIKHONOV, L. I.**  
Analysis of the characteristics of silicon  
photoconverters in the 100-400 K temperature range  
21 p0167 A79-20361
- TILL, J. E.**  
Nonproliferation Alternative Systems Assessment  
Program (NASAP): Preliminary environmental  
assessment of thorium/uranium fuel cycle systems  
[ORNL/TM-6069] 21 p0192 A79-11570
- TINBARIO, T. J.**  
The status of alcohol fuels utilization technology  
for highway transportation  
21 p0003 A79-10035
- TINNEBERG, K. D.**  
Advances in cryogenic engineering. Volume 23 -  
Proceedings of the Conference, University of  
Colorado, Boulder, Colo., August 2-5, 1977  
21 p0084 A79-15301
- TIMOFEEV, A. V.**  
A scheme for direct conversion of plasma thermal  
energy into electrical energy  
22 p0324 A79-31765
- TINAUT, D.**  
Calculation of solar energy incident on  
non-horizontal surfaces over Turkey  
22 p0253 A79-22266
- TITCHENER, A. L.**  
Energy from biomass through hydrolysis of wood  
21 p0003 A79-10036
- TITKOV, A. S.**  
Optimization of an ideal thermionic converter  
22 p0241 A79-20941
- TIWARI, B. K.**  
Heat transfer analysis of flat plate type domestic  
solar water heater  
21 p0140 A79-17489
- TIWARI, S.**  
Diffusion length measurements in Schottky barrier  
GaAs solar cells  
22 p0281 A79-26243
- TLEINAT, B. W.**  
Geothermal power and water production studies at  
the University of California  
[ASME PAPER 78-WA/ENER-7] 21 p0159 A79-19778
- TOBIAS, L.**  
Simulation study of the effect of  
fuel-conservative approaches on ATC procedures  
and terminal area capacity  
[SAE PAPER 780523] 21 p0031 A79-10398  
Dynamic simulation studies of fuel conservation  
procedures used in terminal areas  
22 p0259 A79-23581
- TOFIELD, B. C.**  
Advanced batteries  
21 p0067 A79-14270
- TOKAR, B. Z.**  
Heat transport near the wall of a tokamak reactor  
22 p0324 A79-31764
- TOKAREVA, O. M.**  
A problem of optimizing the setting angle of  
sun-battery panels of concave shape  
21 p0045 A79-12186  
Determining optimal angles of nonconvex solar  
battery panel mounting  
21 p0080 A79-14837
- TOLAND, B. E.**  
Current status of composite flywheel development  
22 p0241 A79-20853
- TOLVINSKAYA, E. V.**  
Theoretical and computational analysis of MHD  
machines with two-layer windings and half-filled  
slots and the inductor edges  
22 p0298 A79-29286
- TONAZIC, W. A.**  
Ceramic applications in the advanced Stirling  
automotive engine  
21 p0051 A79-12851
- TONITA, R. M.**  
Control system for solar hot water system  
22 p0321 A79-31442
- TONIZUKA, H.**  
An optimal standard for solar heating systems  
[ASME PAPER 78-WA/DSC-19] 21 p0159 A79-19765
- TONKIEWICZ, M.**  
Photoelectrolysis of water with semiconductors  
22 p0259 A79-23343
- TONLINSON, R.**  
A minicomputer based data acquisition and analysis  
systems for vertical axis wind turbine testing  
21 p0144 A79-17617
- TONLINSON, R. W.**  
Data acquisition and signal processing for a  
vertical axis wind energy conversion system  
[SAND-78-1000C] 21 p0187 A79-11517
- TONELLI, A. D.**  
The design and evaluation of a 5 GW GaAs solar  
power satellite /SPS/  
21 p0002 A79-10024
- TONGE, G.**  
Thermodynamics of the conversion of diluted  
radiation  
22 p0310 A79-30910
- TONKOGIL, I. L.**  
Selection of thermal operating regimes for fuel  
cell reactor-condenser systems  
21 p0165 A79-20342
- TORII, T.**  
The use of heat exchangers with THERMOEXCEL's  
tubing in ocean thermal energy power plants  
[ASME PAPER 78-WA/HT-65] 21 p0162 A79-19825
- TOROSSIAN, A.**  
Conceptual design of a superconducting tokamak -  
'TORUS II SUPRA'  
22 p0236 A79-20543
- TOUCHAIS, M.**  
Industrial aspects in solar energy instruction  
22 p0254 A79-22274
- TOUSSAINT, M.**  
The utilization of European space techniques for  
energy production  
[IAP PAPER 78-190] 21 p0035 A79-11287
- TOWGOOD, D. A.**  
Composite material flywheel for the  
electric-powered passenger vehicle  
22 p0240 A79-20842
- TOWNES, H. W.**  
Experimental measurements and correlations of  
Nusselt number for MHD high temperature air  
preheaters  
[ASME PAPER 78-WA/HT-22] 21 p0161 A79-19809
- TRACEY, T. R.**  
Alternative central receiver solar power plant  
using salt as a heat transfer and storage medium  
[AIAA PAPER 78-1753] 21 p0060 A79-13855
- TRAB, D. Q.**  
Kinetic modeling of pyrolysis and  
hydrogasification of carbonaceous materials  
21 p0179 A79-11150
- TRAPPBACH, K.**  
Development of ceramic parts for a truck gas  
turbine at MTU  
21 p0050 A79-12831
- TRAUT, R. T.**  
Power cables to accommodate the motions of an OTEC  
plant  
21 p0101 A79-16251
- TREAT, E. L.**  
Net energy analysis of five energy systems  
[ORAU/IEA(R)-77-12] 21 p0174 A79-10534
- TREHAN, R. K.**  
Projecting energy resource utilization - The  
geothermal case  
21 p0068 A79-14321
- TRELA, W.**  
Evaluation of ceramics for stator application:  
Gas turbine engine report  
[NASA-CR-159533] 22 p0364 A79-21075
- TRELLA, M.**  
European aspects of Solar Satellite Power systems  
22 p0326 A79-31923
- TREVILLION, W. L.**  
The external combustion steam injected gas turbine  
for cogeneration  
21 p0012 A79-10100
- TRILLING, C. A.**  
SNG production by the Rockgas process  
21 p0093 A79-15896
- TRIPATHI, V. K.**  
Parametric decay of lower hybrid waves in a plasma  
- Effect of ion nonlinearity  
22 p0269 A79-24814
- TRIPPETT, R. J.**  
Air bearing development for a GM automotive gas  
turbine  
[SAE PAPER 790107] 22 p0314 A79-31355

- TROFINOVA, A. A.**  
Study of the spectral characteristics of metallized polymer films for production of solar concentrators 22 p0297 A79-28672
- TROISE, G.**  
Selective covers for natural cooling devices 22 p0272 A79-25522
- TROVILLION, T. A.**  
MHD generator duct flow with cross stream dependent fluid properties 22 p0336 A79-16668
- TRUDELL, L. G.**  
Colorado's oil-shale resource for vertical modified in-situ processes 21 p0005 A79-10046
- TRUKHOV, V. S.**  
Optimization and design of radiative heat-discharge system for energy unit with Stirling engine 21 p0166 A79-20398
- TRUMBULE, R. E.**  
Research and development needs to merge environmental and energy objectives [GPO-23-254] 22 p0342 A79-17339
- TRUSCELLO, V.**  
JPL - Small Power Systems Applications Project 21 p0019 A79-10161
- TRUSCELLO, V. C.**  
The parabolic concentrating collector: A tutorial [NASA-CR-158246] 22 p0359 A79-20491
- TRZASKONA, W. P.**  
Advances in ocean engineering aspects of ocean thermal energy conversion 21 p0101 A79-16250
- TSAI, C. C.**  
Magnetic multipole line-cusp plasma generator for neutral beam injectors 22 p0238 A79-20746
- TSANALASHVILI, L. V.**  
Cyclotron-wave spectrum in a plasma with two ion species 22 p0245 A79-21443
- TSANG, C. P.**  
Underground aquifer storage of hot water from solar energy collectors 21 p0120 A79-17317
- TSINKOTSKI, B.**  
Storage peak gas-turbine power plant 22 p0268 A79-24507
- TSOULPANIDIS, N.**  
Comparison of nuclear and coal power plants using Net Energy Analysis 21 p0073 A79-14692
- TSUJI, T.**  
The development of photovoltaic conversion systems with sunlight concentration 21 p0148 A79-17995
- TSUKANO, R.**  
Efficiency studies about Daihatsu engine/electric hybrid system [SAE PAPER 790013] 22 p0314 A79-31352
- TUCKER, B. L., JR.**  
The influence of systems and operations on rapid rail energy utilization 22 p0299 A79-29338
- TUKHVALTIN, R. SH.**  
Investigation of the Hall effect in a discharge with a rotational electric field 22 p0246 A79-21532
- TUNG, Y.**  
A study of the effective resistance of the diffused layer and its effect on solar cell performance 22 p0367 A79-21541
- TURCHI, P. J.**  
Compact fusion reactors using controlled imploding liners 21 p0018 A79-10151
- TURNA, K. S.**  
The impact of energy resource development on water resource allocations [PB-286135/9] 21 p0231 A79-15432
- TURNBULL, P. G.**  
Laboratory evaluation of a composite flywheel energy storage system 21 p0013 A79-10110
- TURNER, A. F.**  
Optical design of a solar collector for the advanced solar thermal electric conversion/process heat program [Y/SUB-77/14261] 21 p0209 A79-13528
- TURNER, L. E.**  
A superconducting dipole magnet system for the MHD facility at Univ. of Tennessee Space Institute 21 p0017 A79-10140  
Fabrication experiences and operating characteristics of the U.S. SCMS superconducting dipole magnet for MHD research 21 p0084 A79-15304  
A superconducting dipole magnet for the UTSI MHD Facility 22 p0235 A79-20533
- TURNER, R. D.**  
30-MJ superconducting magnetic energy storage /SMES/ unit for stabilizing an electric transmission system 22 p0237 A79-20555
- TURNER, R. E.**  
Summary of atmospheric wind design criteria for wind energy conversion system development [NASA-TP-1389] 21 p0223 A79-14678  
Engineering handbook on the atmospheric environmental guidelines for use in wind turbine generator development [NASA-TP-1359] 21 p0223 A79-14679
- TURNER, R. H.**  
High temperature thermal energy storage in moving sand 21 p0012 A79-10103
- TURNER, T. F.**  
Combustion rates for oil shale carbonaceous residue 21 p0032 A79-10522
- TVERRIANOVICH, E. V.**  
Facility with sectioned photoreceiver and laser radiator for determining solar radiation concentrator accuracy characteristics 21 p0054 A79-13292
- TYAGI, H. R.**  
Heat transfer analysis of flat plate type domestic solar water heater 21 p0140 A79-17489
- TYMURA, E. J.**  
Solutions to energy conservation in northern climates 22 p0321 A79-31443
- TYNDALL, R. F.**  
Environmental assessment for residual oil utilization [PB-286982/4] 22 p0336 A79-16446
- TYSON, T. J.**  
The fate of fuel nitrogen - Implications for combustor design and operation 21 p0080 A79-14927  
Low NOx combustion concepts for advanced power generation systems firing low-Btu gas [PB-282983/6] 21 p0178 A79-10610
- U**
- UBHAYAKAR, S. K.**  
Combustion of pulverized coal in high temperature preheated air [AIAA PAPER 79-0298] 21 p0158 A79-19654
- UCHIDA, H.**  
Mixing effects of two different types of hydrides 22 p0251 A79-21718
- UCHIDA, T.**  
200-kv Blumlein transmission line for ultrafast toroidal theta-pinch 22 p0297 A79-28917
- UDAGAWA, S.**  
Comparison between simulation and experiment of solar heating 21 p0137 A79-17461
- UHL, V. W.**  
A standard procedure of economic evaluation for energy-producing and pollution-abatement operations 21 p0064 A79-14109
- UHELMAN, E. W.**  
Atlas of western surface-mined lands: Coal, uranium, and phosphate [PB-287846/0] 22 p0340 A79-17311



- ULLI, E.  
The Arbonia control concept - Does flow regulation  
in the solar system cycle make sense  
21 p0056 A79-13632
- ULLMAN, D.  
An introduction to the variable inertia flywheel  
/VIP/  
[ASHE PAPER 79-APH-5] 22 p0298 A79-29064
- UNAROV, G. IA.  
Optimization and design of radiative  
heat-discharge system for energy unit with  
Stirling engine  
21 p0166 A79-20348  
Study of the temperature distribution across the  
width of the screen of low-temperature water  
heaters with tubular heat receivers  
22 p0297 A79-28671
- UNESH, G.  
Performance of solar concentrators - A theoretical  
study  
21 p0135 A79-17453  
Periodic heating/cooling by solar radiation  
21 p0140 A79-17491
- UNOTO, J.  
Three-dimensional effects of electrode  
configuration on diagonal MHD generator  
performance  
22 p0283 A79-26523
- UNDERHILL, B.  
Recommended performance standards for electric and  
hybrid vehicles  
[SAR/1335-1] 21 p0195 N79-12450
- UNKEL, W. C.  
Axial field limitations in MHD generators  
[FE-2341-8] 22 p0362 N79-20512
- UNNEWHR, L. E.  
Pulse characteristics of sodium sulfur cells for  
electric vehicle propulsion  
21 p0009 A79-10082
- UNNY, T. E.  
Methods for reducing heat losses from flat plate  
solar collectors, phase 2  
[COO-2597-4] 21 p0188 N79-11533
- UPTON, C. W.  
Impact of electric passenger automobiles on  
utility system loads, 1985 - 2000  
[EPRI-EA-623] 21 p0203 N79-13281
- URDANETA-BOHORQUEZ, A. R.  
Energy and economic analysis of industrial process  
heat recovery with heat pumps  
22 p0331 N79-16210
- URIE, H. W.  
Explanation for low-efficiency Cu<sub>2</sub>O  
Schottky-barrier solar cells  
22 p0256 A79-22859
- USHER, H.  
Thermal performance evaluation of the Calmac  
(liquid) solar collector  
[NASA-CR-150819] 21 p0173 N79-10521
- V**
- VAIL, Y. E.  
Demetallization catalyst tests on heavy residual  
oils  
[PB-285937/9] 21 p0232 N79-15864
- VAILL, R. E.  
Design and cost study of a nickel-iron oxide  
battery for electric vehicles. Volume 2:  
Public report.  
[ANL-K-3723-VOL-1] 21 p0222 N79-14579
- VAJK, J. P.  
Financial/management scenarios for a satellite  
power system program  
[AAS PAPER 78-144] 22 p0243 A79-21259
- VALDEZ, H. E.  
Controlling a wind generator for increased  
efficiency  
21 p0113 A79-16743
- VALDMANIS, IB. IA.  
Optimality criteria in the compensation of the  
longitudinal boundary effect in induction MHD  
machines  
22 p0298 A79-29277
- VALLANCE, J. K.  
Reliability and durability of ceramic regenerators  
for gas turbine applications  
21 p0050 A79-12823
- VALLET, C. E.  
Migration polarization in high-current density  
molten salt electrochemical devices  
21 p0039 A79-11811  
Steady-state composition profiles in mixed molten  
salt electrochemical devices. II - Molten  
carbonate fuel cell analogs  
22 p0305 A79-30333
- VAN DER LEIJ, H.  
Investigation and perspectives on iron oxide, zinc  
conversion coating, zinc oxide, cobalt oxide and  
tungsten oxide as spectral selective solar  
absorber surfaces  
21 p0126 A79-17375
- VAN DER POT, B. J. G.  
OTEC in Europe  
21 p0152 A79-18109
- VAN DUSEN, E. S.  
A two dimensional vortex sheet model of a Savonius  
Rotor  
22 p0278 A79-26178
- VAN HULSTEYN, D. B.  
Two-dimensional monochromatic X-ray imaging of  
laser-produced plasmas  
22 p0296 A79-28366
- VAN KOPPEN, C. W. J.  
Stratification effects in the short and long term  
storage of solar heat  
21 p0121 A79-17326  
The performance of the heating system in the solar  
house of the Eindhoven University of Technology  
22 p0276 A79-25938
- VAN NAL, H. H.  
Model predictions for the stability of ternary  
metallic hydrides  
21 p0038 A79-11802  
Some applications of LaNi<sub>5</sub>-type hydrides  
22 p0249 A79-21694
- VAN NETER, D. B.  
Operation and emission of a stoker-fired boiler  
while burning refuse derived fuel and coal  
mixtures  
[ASHE PAPER 78-WA/APC-2] 21 p0158 A79-19735
- VAN NICE, L. J.  
Coal desulfurization test plant status - July 1977  
21 p0044 A79-12118
- VAN RIJSWICK, H. H. J.  
Metal hydride electrodes for electrochemical  
energy storage  
22 p0249 A79-21695
- VAN SCIVER, S. W.  
Refrigeration requirements for future  
superconductive energy related applications  
22 p0311 A79-31019
- VAN VELZEN, D.  
Problems around Fe-Cl cycles  
22 p0238 A79-20771
- VANBASSHUISEN, R.  
Update of development on the new Audi NSU rotary  
engine generation  
22 p0329 N79-15965
- VANCE, R. W.  
Applications of cryogenic technology. Volume 7 -  
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Energy Systems, Oak Brook, Ill., May 16-18, 1978  
22 p0289 A79-27651
- VANDERPLAS, P. E.  
Magneto-acoustic resonance heating in the  
ion-cyclotron frequency domain  
22 p0271 A79-24866
- VANDER AREND, P. C.  
Cryogenic aspects of the U.S. SCMS superconducting  
dipole magnet for MHD research  
21 p0084 A79-15303
- VANDERBORGH, W. E.  
Underground thermal generation of hydrocarbons  
from dry, southwestern coals  
21 p0005 A79-10050  
Electrochemical engines for power generation and  
load-leveling at sites for underground coal  
conversion  
21 p0005 A79-10051
- VANDERPLAS, R. A.  
High performance GaAs photovoltaic cells for  
concentrator applications  
[SAND-78-7018] 21 p0187 N79-11521

- VANDERWERF, D. P.  
Linear echelon refractor/reflector solar concentrators  
22 p0293 A79-28143
- VANDEVENDER, S. G.  
Preliminary economic analysis of Solar Irrigation Systems (SIS) for selected locations [SABD-77-1403]  
21 p0220 A79-14566
- VANDUSEN, E. S.  
Two-dimensional analysis of vertical axis windmills  
22 p0353 A79-19446
- VANKAR, V. D.  
Stoichiometric Cu<sub>2</sub>S thin films for solar cells  
21 p0123 A79-17349
- VANLOON, H.  
Multidisciplinary research related to the atmospheric sciences [PB-283076/8]  
21 p0179 A79-10679
- VANNEETER, D. B.  
Source emissions factors for refuse derived fuels  
21 p0082 A79-15084
- VARADY, J. H.  
Local perceptions of energy development: The case of the Kaiparowits Plateau [PB-287314/9]  
22 p0335 A79-16380
- VARDE, K. S.  
Partial energy supply to electric vehicles through solar cell system  
21 p0077 A79-14767
- VARGANOVA, L. P.  
Hybrid reactor based on laser-induced thermonuclear fusion  
21 p0032 A79-10658
- VARLET GRANCHER, C.  
Efficiency of sugar cane and cowpea as solar energy converters  
21 p0125 A79-17368
- VARNA, A. K.  
Modeling two-phase flow in a swirl combustor  
22 p0280 A79-26189
- VARSII, G.  
Feasibility of rocket propellant production on Mars  
21 p0047 A79-12324
- VARTANIAN, A. V.  
Controlling the radiant flux of a high-temperature solar energy conversion system over two parameters  
22 p0296 A79-28669
- VASAGAN, R. E.  
Enhanced power generation by optical solar reflectors on geostationary spinners  
22 p0272 A79-25138
- VASILEVA, I. A.  
Plasma diagnostics in an MHD installation  
21 p0106 A79-16492
- VASILEVSKII, E. A.  
Dynamic stabilization of toroidal discharges in weak longitudinal magnetic fields  
22 p0324 A79-31766
- VASU, K. I.  
Spectral selective properties of black chrome and nickel electrodeposited coatings for solar absorber  
21 p0127 A79-17383
- VASUDEVAN, E.  
New processes for black coatings useful in harnessing solar energy. I - A room temperature black chromium plating bath  
21 p0127 A79-17379
- VAUGH, C.  
Simulation and cost of photovoltaic generators  
21 p0122 A79-17334
- VAUGHAN, D. A.  
Chloride corrosion and its inhibition in refuse firing  
21 p0080 A79-14930
- Corrosion and deposits from combustion of solid waste. VI - Processed refuse as a supplementary fuel in a stoker-fired boiler [ASME PAPER 78-WA/PU-4]  
21 p0160 A79-19788
- VEEPKIND, A.  
Performance of a closed-cycle MHD generator with molecular impurities  
22 p0283 A79-26524
- Experimental investigation on the discharge structure in a noble gas MHD generator [TB-78-E-79]  
22 p0350 A79-18758
- VEERENCAMP, J. E.  
Electromagnetic radiation energy arrangement [NASA-CASE-WOO-00428-1]  
22 p0352 A79-19186
- VEILLETTE, D.  
Contribution to the development of wind energy systems using static power electronic converters  
22 p0286 A79-26958
- Control strategy for a variable-speed wind energy conversion system  
22 p0303 A79-29800
- VELIKHOV, E. P.  
Controlled thermonuclear fusion  
22 p0287 A79-27339
- VELKOFF, E.  
An introduction to the variable inertia flywheel /VIP/ [ASME PAPER 79-APM-5]  
22 p0298 A79-29064
- VELTHUIS, B. V.  
Biological solar energy conversion approaches to overcome yield stability and product limitations [PB-284823/2]  
21 p0199 A79-12577
- VENEMA, W. J.  
Electronic states of concentrated Pd-H alloys from de Haas-van Alphen measurements  
22 p0248 A79-21686
- VERHOLEK, E. G.  
Preliminary results of a field experiment to characterize wind flow through a vertical plane [PNL-2518]  
21 p0203 A79-13322
- VERNA, E. L.  
Effect of buoyancy and tube inclination on heat transfer in a solar air heater  
21 p0129 A79-17402
- VERNA, V. K.  
Design, construction and performance of Fresnel lens for solar energy collection  
21 p0136 A79-17456
- VERNA, V. V.  
Design of radiometer for measurement of total and net exchange solar radiation  
21 p0119 A79-17307
- VERNES, G.  
Thermophoresis - Enhanced deposition rates in combustion turbine blade passages [ASME PAPER 78-WA/GT-1]  
21 p0160 A79-19790
- VERHEAU, A.  
Use of organic fluids in solar turbines  
22 p0269 A79-24621
- VEZIROGLU, T. H.  
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21 p0076 A79-14760
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21 p0102 A79-16451
- Principles of solar cooling and heating  
21 p0103 A79-16457
- Application of solar cooling for a school building in subtropics  
21 p0103 A79-16461
- Solar-hydrogen energy system and solar-hydrogen production methods  
21 p0104 A79-16463
- VIALARON, A.-C.  
A hybrid chemical concept for solar energy storage  
22 p0254 A79-22271
- VIDEN, K.  
Electrochemical utilization of metal hydrides  
22 p0251 A79-21709
- VIELSTICH, W.  
The anodic oxidation of ethyleneglycol at platinum, gold and Pt/Au-alloys in alkaline solution  
21 p0037 A79-11795
- Recent advances in electrocatalysis and their implications for fuel cells  
21 p0038 A79-11807
- VIJ, S. K.  
Geometrical aspects of a cylindrical parabolic collector  
21 p0134 A79-17443
- VIKHREV, V. V.  
Structure of the current shell in a Z pinch  
22 p0245 A79-21434
- VILNITIS, A. IA.  
Accounting for the effect of a yoke in an MHD linear induction machine by stipulating boundary conditions of a new kind  
22 p0247 A79-21627

- VINUKTA, D.**  
Integrating wave power into the electricity supply system  
21 p0152 A79-18117
- VINOGRADOVA, E. B.**  
Spectral characteristics of photoconverters with nonuniform defect distribution in the base  
21 p0053 A79-13289
- VISKANTA, R.**  
Some aspects of the transient response of a flat-plate solar energy collector  
21 p0153 A79-18466  
Slag transport models for radiant heater of an MHD system  
[ASME PAPER 78-WA/HT-21] 21 p0161 A79-19808  
Heat transfer in a solar radiation absorbing fluid layer flowing over a substrate  
22 p0281 A79-26204
- VISWANATHAN, T. L.**  
Sensitivity calculations for the design of solar cells. I - Schottky barrier devices  
21 p0125 A79-17360
- VITANOV, T.**  
Influence of composition on the activity of tungsten carbide gas diffusion hydrogen electrodes  
22 p0245 A79-21482
- VITORELLO, I.**  
Heat flow and radiogenic heat production in Brazil with implications for thermal evolution of continents  
22 p0373 A79-21689
- VITRAY, R.**  
System for projecting the utilization of renewable resources. SPURR methodology  
[ERHQ/2322-77/4] 21 p0174 A79-10538
- VOELKER, H.**  
Solar energy and heat insulation  
22 p0268 A79-24321
- VOGEL, G. J.**  
Factors limiting limestone utilization efficiency in fluidized-bed combustors  
21 p0008 A79-10069  
Limestone SO<sub>2</sub> reactivity and causes for reactivity loss during multi cycle utilization  
21 p0065 A79-14121
- VOGT, D. P.**  
Energy availabilities for state and local development: 1973 data volume  
[ORNL/TM-5890-S2] 21 p0175 A79-10541  
Energy availabilities for state and local development: 1974 data volume  
[ORNL/TM-5890-S3] 21 p0175 A79-10542  
Energy availabilities for state and local development: Projected energy patterns for 1980 and 1985  
[ORNL/TM-5890/54] 21 p0186 A79-11511
- VOGT, J. F.**  
Recent terrestrial and undersea applications of radioisotope thermoelectric generators /RTGs/  
21 p0027 A79-10226  
Determining the reliability of radioisotope thermoelectric generators /RTGs/ designed for terrestrial and undersea applications  
22 p0261 A79-23622  
Recent terrestrial and undersea applications of radioisotope thermoelectric generators /RTGs/  
22 p0261 A79-23623
- VOGT, W. G.**  
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22 p0263 A79-23776
- VOJDAHI, S.**  
Solar energy R&D in Iran - The approach and the philosophy  
21 p0117 A79-17284  
Solar thermal electrical power plants for Iran  
22 p0295 A79-28352
- VOLDEK, A. I.**  
Theoretical and computational analysis of MHD machines with two-layer windings and half-filled slots and the inductor edges  
22 p0298 A79-29286
- VOLOVIR, A. V.**  
High-temperature oxidizer preheater  
21 p0106 A79-16487
- VON BASSEWITZ, H.**  
Development and testing of the ULP solar array  
21 p0029 A79-10245
- VON HATTEH, P. P.**  
Sensible heat storage for solar energy applications  
22 p0322 A79-31449
- VON ROSENBERG, C. W., JR.**  
Shock tube studies of coal devolatilization  
21 p0083 A79-15247
- VON WALDKIRCH, T.**  
Hydrides of rare earth-nickel compounds - Structure and formation enthalpies  
22 p0250 A79-21697
- VON WIENSKOWSKI, J.**  
Selective solar absorbers  
21 p0057 A79-13646
- VORA, H. K.**  
Low-Btu gas from the IGT ash-agglomeration gasification process  
21 p0009 A79-10077
- VORONOV, G. S.**  
Properties of the plasma ions and the particle lifetime in ohmic heating in the L-2 stellarator  
22 p0244 A79-21428
- VOROSHARTY, C. J.**  
Environmental impacts of industrial energy systems in the coastal zone  
21 p0075 A79-14722
- VOSS, E.**  
Progress in batteries and solar cells. Volume 1  
21 p0148 A79-17989
- VRABLE, D. L.**  
High efficiency thermal energy storage system for utility applications  
21 p0012 A79-10102  
Energy distribution and storage alternates with a centralized heat source  
21 p0013 A79-10112
- VRABOS, A.**  
Liquid-phase reactions of vaporizing hydrocarbon fuels  
21 p0052 A79-12987  
Analytical evaluation of the impact of broad specification fuels on high bypass turbofan engine combustors  
[NASA-CR-159454] 21 p0200 A79-13050
- VIAS, Y. K.**  
The external combustion steam injected gas turbine for cogeneration  
21 p0012 A79-10100

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- WACHTER, R. A.**  
Source assessment: Water pollutants from coal storage areas  
[PB-285420/6] 21 p0223 A79-14635  
Source assessment: Open mining of coal. State of the Art  
[PB-288497/1] 22 p0353 A79-19429
- WADDELL, B. V.**  
Non-linear numerical algorithms for studying tearing modes  
22 p0257 A79-22981
- WAGNER, S.**  
n-CdS/n-GaAs photoanode  
21 p0037 A79-11784  
High efficiency solar cells based on indium phosphide  
21 p0042 A79-11968
- WAGNER, W. R.**  
A high-efficiency GaAlAs double-heterostructure photovoltaic detector  
21 p0154 A79-18489
- WAGONER, D. E.**  
Pollutants from synthetic fuels production: Facility construction and preliminary tests  
[PB-287730/6] 22 p0339 A79-17027
- WAHLIG, H.**  
The circumsolar measurement program - Assessment of the effects of atmospheric scattering on solar energy conversion  
21 p0082 A79-15077

PERSONAL AUTHOR INDEX

WARNOCK, J. G.

- WAKIM, P. G.  
Photovoltaic effect in  
metal-insulator-semiconductor structure  
21 p0123 A79-17343
- WAKSHAN, D.  
Plan for the development and implementation of  
standards for solar heating and cooling  
applications  
[PB-283237/6] 21 p0190 N79-11543  
Provisional flat plate solar collector testing  
procedures  
[PB-283721/9] 21 p0198 N79-12571
- WALD, D. A.  
Selenide thermoelectric converter technology  
21 p0026 A79-10221
- WALD, F. V.  
Large area silicon sheet by EFG  
21 p0123 A79-17340  
Large area silicon sheet by EFG  
[NASA-CR-158379] 22 p0359 N79-20483
- WALDRON, K. J.  
Design considerations of small solar collector  
systems using plane heliostats  
[ASME PAPER 79-SOL-2] 22 p0307 A79-30540
- WALKER, B. J.  
Factors influencing solar energy commercialization  
21 p0093 A79-15897
- WALKER, B. V.  
Transport fuels from natural gas  
22 p0292 A79-27897
- WALKER, D. H.  
The NTS-2 satellite solar cell experiment  
21 p0001 A79-10016
- WALKER, H. S.  
Conductor for LASL 10-MWhr superconducting energy  
storage coil  
21 p0085 A79-15309
- WALKER, P.  
Electric power from laser fusion - The HYLIFE  
concept  
21 p0030 A79-10249  
Civilian applications of laser fusion  
[UCL-52349] 21 p0195 N79-12439
- WALKER, W. E.  
Measurement of heat loss from a heat receiver  
assembly of a Fixed Mirror Solar Concentrator  
21 p0020 A79-10166
- WALLACE, W. E.  
Structure and bonding in metal hydrides  
22 p0247 A79-21679  
Magnetic and electrical properties of rare earth  
and rare earth intermetallic hydrides  
22 p0249 A79-21692  
Rare earth and actinide intermetallics as  
hydrogenation catalysts  
22 p0251 A79-21713
- WALLY, K.  
Solar Total Energy Test Facility project test  
results: High-temperature thermocline storage  
subsystem  
[SAND-77-1528] 21 p0197 N79-12565
- WALSE, B.  
Engine technology for production turbofan engines  
22 p0270 A79-24827
- WALTER, H.  
Proceedings of symposium on water-in-fuel  
emulsions in combustion  
[AD-A061503] 22 p0338 N79-17019
- WALTER, H. A.  
The emissions and fuel economy of a Detroit diesel  
6-71 engine burning a 10-percent water-in-fuel  
emulsion  
[AD-A058550] 21 p0203 N79-13375
- WALTERS, C. T.  
Magnetically confined plasma solar collector  
21 p0109 A79-16617
- WALTERS, E. A.  
Underground coal gasification research at the  
University of New Mexico  
21 p0032 A79-10523
- WALTON, G. M.  
Design of solar heating and cooling systems  
[AD-A062719] 22 p0363 N79-20522
- WALTON, J. D.  
A ceramic heat exchanger for a Brayton cycle solar  
electric power plant  
22 p0239 A79-20822
- WALTON, J. D., JR.  
Preliminary results from the Georgia Tech 400 kWth  
Solar Thermal Test Facility  
21 p0141 A79-17499
- WALTE, R. E.  
A calculation of linear magnetic liner fusion  
reactor performance  
21 p0018 A79-10153  
Empirical scaling laws for energy confinement in  
ohmically-heated tokamaks  
22 p0253 A79-22240
- WALZER, P.  
Ceramic components for vehicular gas turbines  
21 p0034 A79-11150  
Development of multi-density silicon nitride  
turbine rotors  
21 p0050 A79-12832
- WANDER, S. M.  
Program to establish ceramic technology readiness  
for large combustion turbine utility application  
[ASME PAPER 78-WA/GT-8] 21 p0160 A79-19796
- WANG, H. F.  
Thermoelastic solutions for in-situ gasification  
of coal  
22 p0330 N79-16135
- WANG, H. Y.  
Particle orbits in field-reversed mirrors  
22 p0253 A79-22239
- WANG, P. H.  
Wind power from a vortex chamber  
22 p0319 A79-31425
- WANG, S. T.  
Cryogenic aspects of the U.S. SCMS superconducting  
dipole magnet for MHD research  
21 p0084 A79-15303  
Fabrication experiences and operating  
characteristics of the U.S. SCMS superconducting  
dipole magnet for MHD research  
21 p0084 A79-15304
- WANG, S.-T.  
A superconducting dipole magnet system for the MHD  
facility at Univ. of Tennessee Space Institute  
21 p0017 A79-10140  
A superconducting dipole magnet for the UTSI-MHD  
Facility  
22 p0235 A79-20537
- WARCHOL, E. J.  
Wind power potential in the Pacific Northwest  
22 p0244 A79-21334
- WARD, D. S.  
Integration of evacuated tubular solar collectors  
with lithium bromide absorption cooling systems  
21 p0139 A79-17483  
Design considerations for residential solar  
heating and cooling systems utilizing evacuated  
tube solar collectors  
22 p0285 A79-26815  
Solar absorption cooling feasibility  
22 p0295 A79-28358
- WARD, J. C.  
Integration of evacuated tubular solar collectors  
with lithium bromide absorption cooling systems  
21 p0139 A79-17483  
Design considerations for residential solar  
heating and cooling systems utilizing evacuated  
tube solar collectors  
22 p0285 A79-26815
- WARDE, C. J.  
100MWh zinc-chlorine peak-shaving battery plants  
21 p0011 A79-10096
- WARFIELD, G.  
Solar energy research, development and  
demonstration program in Kuwait  
21 p0117 A79-17282
- WARNEBRODT, W.  
Aeroelastic response and stability of a coupled  
rotor/support system with application to large  
horizontal axis with turbines  
22 p0332 N79-16346
- WARNE, D. F.  
Design and application of large wind turbine  
generators  
22 p0326 A79-31916
- WARNOCK, J. G.  
Selection of optimum sites for tidal power  
development in the Bay of Fundy  
21 p0152 A79-18110

- WARREN, A. W.  
SINWEST - A simulation model for wind energy storage systems  
21 p0029 A79-10241
- WARTANOWICZ, T.  
Optimization method of isotopic thermoelectric microgenerator geometry  
22 p0260 A79-23613
- WATANABE, T.  
Highly efficient quantum conversion at chlorophyll a-lecithin mixed monolayer coated electrodes  
22 p0273 A79-25548
- WATERBURY, G. B.  
Environmental and radiological safety studies. Interaction of (Pu-238)O<sub>2</sub> heat sources with terrestrial and aquatic environments [LA-7033-PR]  
21 p0232 B79-15783
- WATERS, M. D.  
Status of bioscreening of emissions and effluents from energy technologies  
22 p0346 B79-18353
- WATKINS, J. L.  
Effect of solar cell parameter variation on array power output [SAND-78-0917C]  
21 p0188 B79-11527
- WATSON, H. C.  
Some problems and benefits from the hydrogen fueled spark ignition engine  
21 p0016 A79-10130
- WATSON, J. J.  
Energy consumption of environmental controls - Fossil fuel, steam electric generating industry  
21 p0064 A79-14112
- WATTS, A. W.  
A proposed conceptual plan for integration of wind turbine generators with a hydroelectric system  
21 p0098 A79-16107
- WAY, S.  
A proposed 40 MWe MHD pilot plant  
21 p0017 A79-10137
- WEATHERS, H. M.  
Rankine cycle machines for solar cooling [NASA-TM-78196]  
21 p0173 B79-10524
- WEBB, G. B.  
Engineering and bench-scale studies of the sulfur-iodine cycle at General Atomic  
21 p0015 A79-10127
- WEBER, H. E.  
High efficiency wave engine  
22 p0279 A79-26187
- WEBER, H. J.  
Requirements and new materials for fusion laser systems  
21 p0082 A79-15138
- WEBER, H.  
Research on the sodium heat engine  
21 p0028 A79-10231
- WEBER, R. J.  
NASA research on general aviation power plants [NASA-TM-79031]  
21 p0194 B79-12086
- WEBSTER, W. H.  
Battery and electrochemical systems program summary, FY 1977 [DOE/ET-0014]  
21 p0176 B79-10546
- WEDDIGEN, G.  
Recent advances in Na/S cell development - A review  
22 p0246 A79-21488
- WEDEL, R. K.  
An approximate equation for predicting the solar transmittance of transparent honeycombs  
21 p0042 A79-11877
- WEGLEY, H. L.  
Siting handbook for small wind energy conversion systems [PNL-2521]  
21 p0209 B79-13527
- Wind characteristics program element [PNL-2545]  
22 p0356 B79-19568
- WEI, P.-S.  
Lag damping in autorotation by a perturbation method [AHS 78-25]  
21 p0152 A79-18151
- WEI, J.  
Feasible operating regions for moving bed coal gasification reactors  
22 p0297 A79-28983
- WEI, R. P.  
Environmentally induced cracking of natural gas and liquid pipelines. Volume 2: Appendices A and B [PB-282924/0]  
21 p0181 B79-11446
- Environmentally induced cracking of natural gas and liquid pipelines. Volume 1: Technical report [PB-282923/2]  
21 p0181 B79-11447
- WEIR, H.  
Simple high-accuracy diode temperature-difference control circuit  
21 p0056 A79-13631
- WEIN, D.  
Mini-Brayton heat source assembly development [NASA-CR-159447]  
21 p0196 B79-12554
- WEINER, S. G.  
Solids mixing and fluidization characteristics in a tube filled bed  
21 p0008 A79-10070
- WEINGART, O.  
Large filament wound structures for energy and transportation systems  
21 p0086 A79-15507
- WEISBRICH, A. L.  
Toroidal Accelerator Rotor Platforms for wind energy conversion  
21 p0029 A79-10240
- Alternative energy for domestic hot water - Wind or solar  
21 p0067 A79-14292
- Toroidal accelerator rotor platforms for wind energy conversion  
21 p0077 A79-14770
- WEISBRICK, A. L.  
Feature review of some advanced and innovative design concepts in wind energy conversion systems  
21 p0077 A79-14771
- WEISBRODT, I.  
Substitute natural gas from coal using high-temperature reactor heat - Project 'Prototype Plant Nuclear Process Heat'  
22 p0264 A79-23827
- WEISER, G.  
Chemical vapor deposited amorphous silicon for use in photothermal conversion  
22 p0294 A79-28149
- WEISS, A. J.  
Synthane - A process for the gasification of caking and noncaking coals  
21 p0006 A79-10057
- WEISS, J. A.  
DOE programs in material development for fusion laser systems  
21 p0082 A79-15137
- WEISS, R. S.  
Characterization of solar cells for space applications. Volume 4: Electrical characteristics of Spectrolab BSP 200-micron Helios cells as a function of intensity and temperature [NASA-CR-157934]  
21 p0195 B79-12543
- WEISSBERG, B. G.  
Mercury in some New Zealand geothermal discharges  
22 p0257 A79-22925
- WEISZ, P. B.  
Novel technology for conversion of methanol and synthesis gas to hydrocarbons  
21 p0007 A79-10064
- WEITHAS, P.  
Sun-position diagrams using examples from Flensburg to Hittenwald  
21 p0055 A79-13626
- WELCH, B. W.  
Potential research problems in energy systems analysis  
21 p0115 A79-17221
- WELLER, S. W.  
Catalytic hydrodesulfurization and liquefaction of coal - Batch autoclave studies  
22 p0282 A79-26465
- WELLS, A. A.  
Experiences with a hydropneumatic wave power device  
21 p0151 A79-18105
- WELLS, C. H.  
Environmentally induced cracking of natural gas and liquid pipelines. Volume 2: Appendices A and B [PB-282924/0]  
21 p0181 B79-11446
- Environmentally induced cracking of natural gas and liquid pipelines. Volume 1: Technical report [PB-282923/2]  
21 p0181 B79-11447

## PERSONAL AUTHOR INDEX

WHITEHEAD, H. L.

- WELSH, L. B.  
Optimization of PtDoped KOCITE (trade name)  
electrodes in H<sub>3</sub>PO<sub>4</sub> fuel cells  
[AD-A061242] 22 p0342 N79-17340
- VEN, L.  
Thermal performance trade-offs for point focusing  
solar collectors 21 p0020 A79-10165
- VEN, L. C.  
Solar receiver performance of point focusing  
collector system  
[ASME PAPER 78-WA/SOL-5] 21 p0163 A79-19838
- WENDELL, L. L.  
Wind characteristics program element  
[PNL-2545] 22 p0356 N79-19568
- WENDER, I.  
Exploratory research in coal conversion  
21 p0007 A79-10061
- WENTWORTH, D. E.  
Techniques for preventing damage to high power  
laser components 21 p0083 A79-15145
- WENZEL, H.  
Solar heating and safety techniques  
21 p0056 A79-13633
- WENZEL, L. H.  
Power train analysis for the DOE/NASA 100-kW wind  
turbine generator  
[NASA-TM-78997] 22 p0333 N79-16355
- WENZEL, H.  
The use of Peri-hydride for production and storage  
of suprapure hydrogen 22 p0250 A79-21700
- WENZLER, S. A.  
Evaluation of control options for solar climate  
control systems  
[AIAA PAPER 78-1758] 21 p0060 A79-13859
- WERSINGER, J. H.  
Wave reflection from the lower hybrid surface - A  
toroidal effect 22 p0255 A79-22427
- WESLEY, D. P.  
A mass and energy balance of a Wellman-Galusha  
gasifier 22 p0283 A79-26467
- WESHER, G. H.  
There is a lot of energy in digester gas . . . use  
it 21 p0035 A79-11448
- WESSLING, P. C.  
Predicting the performance of passive solar-heated  
buildings 21 p0063 A79-13899
- WEST, H. H.  
Hydrocarbon working fluid and operating conditions  
selection for the conventional geothermal binary  
cycle 21 p0015 A79-10124
- WESTBROOK, C. K.  
Computer modeling of automotive engine combustion  
[UCRL-80451] 21 p0181 N79-11412
- WESTBROOKLAND, J. S.  
Second-generation integrated coal  
gasification/combined-cycle power systems  
[ASME PAPER 78-GT-14] 21 p0032 A79-10778
- WESTPHAL, S.  
Novel duplex vapor electrochemical method for  
silicon solar cells  
[NASA-CR-158039] 21 p0218 N79-14537
- WETZEL, R. S.  
Standards of Practice Manual for the solvent  
refined coal liquefaction process  
[PB-283028/9] 21 p0178 N79-10595
- WERNERKA, E. H.  
Trace element characterization and  
removal/recovery from coal and coal wastes  
[LA-7048-PR] 21 p0222 N79-14602
- WEYANT, J. P.  
A comparative analysis of three of ERDA's major R  
& D programs 21 p0099 A79-16121
- WEYLER, G. H., JR.  
Rotatable mass for a flywheel  
[NASA-CASE-RPS-23051-1] 21 p0172 N79-10422
- WEYMANTS, R. B.  
Magneto-acoustic resonance heating in the  
ion-cyclotron frequency domain 22 p0271 A79-24866
- WHALEY, T. P.  
Solar total energy systems 21 p0090 A79-15863
- WHARTON, L.  
Compound parabolic concentrators with  
non-evacuated receivers - Prototype performance  
and a larger scale demonstration in a school  
heating system 21 p0134 A79-17440
- WHEALTON, J. H.  
Effect of electrode shielding on beamlet-beamlet  
interaction in multiaperture sources 21 p0154 A79-18481
- WHELOCK, T. D.  
Coal desulfurization: Chemical and physical  
methods; Proceedings of the Symposium, New  
Orleans, La., March 23, 1977 21 p0044 A79-12114
- WHERRY, D. B.  
A synoptic description of coal basins via image  
processing  
[NASA-CR-157970] 21 p0204 N79-13474
- WHITAKER, R.  
Scaling up coal liquids 21 p0031 A79-10475
- WHITBECK, J. F.  
Measurement and control techniques in geothermal  
power plants  
[TREE-1312] 22 p0362 N79-20508
- WHITE, I. L.  
Technology assessment of western energy resource  
development 22 p0347 N79-18368
- WHITE, J.  
Proceedings of symposium on water-in-fuel  
emulsions in combustion  
[AD-A061503] 22 p0338 N79-17019
- WHITE, J. D.  
Technical and environmental aspects of oil shale  
processing 21 p0199 N79-12581
- WHITE, J. H.  
Ranking and evaluation of flat-plate collectors -  
Two new approaches 22 p0316 A79-31402
- WHITE, L. R.  
Progress in the testing of materials and design  
concepts for directly-fired MHD air heater service  
21 p0017 A79-10141
- WHITE, H.  
Preliminary assessment of the environmental  
impacts of the Satellite Power System/SPS/  
22 p0326 A79-31922
- WHITE, O. L.  
FY 1978 scientific and technical reports,  
articles, papers, and presentations  
[NASA-TM-78203] 21 p0214 N79-13915
- WHITE, P. R.  
Solar tracking control system Sun Chaser  
[NASA-TM-78199] 21 p0172 N79-10514
- WHITE, R.  
Theory of dissipative drift instabilities in  
sheared magnetic fields 22 p0292 A79-27884
- WHITE, R. A.  
Encapsulation task of the low-cost silicon solar  
array project. Investigation of test methods,  
material properties, and processes for solar  
cell encapsulants  
[NASA-CR-157939] 21 p0195 N79-12544
- WHITE, R. B.  
Non-linear numerical algorithms for studying  
tearing modes 22 p0257 A79-22981
- WHITEHEAD, A.  
A comparison of the performance of steam turbine  
cycles using gas contaminated geothermal steam  
[ASME PAPER 78-WA/ENER-3] 21 p0159 A79-19776
- WHITEHEAD, G. T.  
Microprocessor control of a wind turbine generator  
22 p0244 A79-21302
- Microprocessor control of a wind turbine generator  
[NASA-TM-79021] 21 p0195 N79-12548
- WHITEHEAD, H. L.  
A high energy tubular battery for a 1800 kg  
payload electric delivery van  
[SAE PAPER 790162] 22 p0315 A79-31367

## WHITFORD, D. H.

The Madaras Rotor Power Plant - An alternate method for extracting large amounts of power from the wind  
[AIAA PAPER 79-0115] 21 p0157 A79-19541

## WHITMAN, R. F.

Engineering and economic analysis of waste to energy systems  
[PB-285797/7] 21 p0224 N79-14946

## WHITRIDGE, J. E.

Filon panels - A technical report 21 p0031 A79-10403

## WHITTAKER, T. J. T.

Experiences with a hydropneumatic wave power device 21 p0151 A79-18105

## WHITTLE, C. E.

Net energy analysis of five energy systems  
[ORAU/IEA(R)-77-12] 21 p0174 N79-10534

## WHITTLESEY, C. C.

100MWh zinc-chlorine peak-shaving battery plants 21 p0011 A79-10096

## WICKEN, G. W.

The London Electric Delivery Van Assessment Scheme  
[SAE PAPER 790111] 22 p0314 A79-31358

## WICKENS, A. E.

The impact of aeronautical sciences on other modes of transport 22 p0325 A79-31915

## WICKS, F. E.

Development and application of techniques to evaluate cogeneration impacts 22 p0303 A79-29795

## WICKSON, R.

Design and operating experience of the cryogenic system of the U.S. SCNS as incorporated into the bypass loop of the U-25 MHD generator facility 22 p0235 A79-20532

## WIEBE, H. A.

A survey of energy information systems and its implications for industrial energy management 21 p0072 A79-14685

## WIEBELT, J. A.

Selected ordinates for total solar radiant property evaluation from spectral data 22 p0271 A79-25060

## WIETING, A. R.

Recent advances in convectively cooled engine and airframe structures for hypersonic flight 21 p0165 A79-20087

## WIGTON, H. P.

Corrosion of superalloys, inconels, and stainless steels by the products from fluidized-bed coal combustion 21 p0080 A79-14932

## WIJEYSUNDERA, M. E.

Transient energy removal in cylindrical parabolic collector systems 21 p0020 A79-10168

Comparison of transient heat transfer models for flat plate collectors 22 p0242 A79-21168

## WILDE, P.

Environmental considerations for siting an ocean thermal conversion early ocean testing platform at four proposed areas 22 p0287 A79-27377

## WILDIN, H. W.

Experience gained and lessons learned from monitoring the solar building, Albuquerque 21 p0088 A79-15833

## WILES, C. C.

Evaluation of the Ames, Iowa refuse derived fuel recovery system 21 p0064 A79-14115

## WILBY, R. L.

Development of a 1 kW/e/ isotope fueled Stirling cycle power system 21 p0025 A79-10210

## WILKINSON, W. H.

Closed Cycle Gas Turbine power generation opportunities 21 p0004 A79-10039

## WILL, F. G.

Symposium on Electrode Materials and Processes for Energy Conversion and Storage, Philadelphia, Pa., May 9-12, 1977, Proceedings 21 p0036 A79-11776

Thermodynamic and kinetic considerations on zinc-halogen batteries 21 p0040 A79-11822

## WILLENBERG, H. J.

Self-consistent analysis of alpha-particle heating of a fast-solenoid plasma 22 p0291 A79-27879

## WILLIAMS, A.

Combustion of droplets and sprays of some alternative fuels 21 p0052 A79-12983

## WILLIAMS, B. F.

Do photovoltaics have a future  
[ASME PAPER 79-SOL-7] 22 p0308 A79-30543

## WILLIAMS, J.

The effects of different energy strategies on the atmospheric CO2 concentration and climate 21 p0106 A79-16523

## WILLIAMS, J. E.

Trace element characterization and removal/recovery from coal and coal wastes  
[LA-7048-PR] 21 p0222 N79-14602

## WILLIAMS, J. E.

Moderate cost, calculator-based data acquisition for solar HVAC systems 21 p0088 A79-15837

## WILLIAMS, K.

High temperature solar collector of optimal concentration - Non-focusing lens with secondary concentrator 21 p0135 A79-17448

## WILLIAMS, O. E.

The efficiencies of thermochemical energy transfer 21 p0054 A79-13575

Energy storage efficiency for the ammonia/hydrogen-nitrogen thermochemical energy transfer system 22 p0261 A79-23718

Screening reversible reactions for thermochemical energy transfer 22 p0285 A79-26823

## WILLIAMS, R. J.

Transient shutdown analysis of low-temperature thermal diodes  
[NASA-TP-1369] 22 p0346 N79-18287

## WILLIAMS, R. O.

Steam raising with low-Btu gas generators and potential for other applications 21 p0072 A79-14690

## WILLIFORD, R. E.

Stored energy calculation: The state of the art  
[PNL-2581] 21 p0210 N79-13541

## WILLIS, D. C.

The energy dilemma: A challenge for Maryland. Proceedings Maryland General Assembly/AISLE Conference  
[PB-284703/6] 21 p0199 N79-12579

## WILLIS, E. A.

NASA research on general aviation power plants  
[NASA-TN-79031] 21 p0194 N79-12086

General aviation energy-conservation research programs 22 p0329 N79-15963

## WILLIS, F. B.

Encapsulation task of the low-cost silicon solar array project. Investigation of test methods, material properties, and processes for solar cell encapsulants  
[NASA-CN-157939] 21 p0195 N79-12544

## WILLRATH, E.

The measurement of optical properties of selective surfaces using a solar calorimeter 21 p0041 A79-11874

## WILSHEN, C.

Potential for low cost, high efficiency solar cells using indium tin oxide on semiconductor /OSOS/ solar cells 21 p0122 A79-17338

## WILSON, A.

Simulated hail impact testing of photovoltaic solar panels 21 p0098 A79-16116

## WILSON, C. W.

Mathematical models of direct initiation of unconfined gas phase detonations  
[AIAA PAPER 79-0289] 21 p0157 A79-19649

## WILSON, D. B.

The direct reduction of sulfur dioxide 21 p0065 A79-14124

- WILSON, E. M.  
Studies in retiming tidal energy  
Engineering and economic analysis of waste to  
energy systems [PB-285797/7] 21 p0152 A79-18115  
21 p0224 A79-14946
- WILSON, G. L.  
MIT-DOE program to demonstrate an advanced  
superconducting generator 22 p0236 A79-20549
- WILSON, J. I. B.  
The interfacial layer in HfS amorphous silicon  
solar cells 22 p0258 A79-23039
- WILSON, K. L.  
Alpha transport and blistering in tokamaks  
22 p0253 A79-22243
- WILSON, R. C.  
Total solar irradiance at Table Mtn, California  
1926-77 21 p0067 A79-14269
- WILSON, R. E.  
Vortex sheet analysis of the Gironmill  
21 p0031 A79-10278  
Vortex sheet analysis of the Gironmill  
22 p0278 A79-26179
- WILSON, W.  
Coal liquefaction support studies. Task 1: Heat  
of reaction of hydrogen with coal slurries.  
Task 2: Heat transfer coefficient  
[ANL/CEN/FE-77-5] 21 p0216 A79-14242
- WILSON, W. I.  
Limestone SO<sub>2</sub> reactivity and causes for reactivity  
loss during multi cycle utilization 21 p0065 A79-14121
- WINANT, J. H.  
Impact of fuel availability and other cost trends  
on general aviation 21 p0053 A79-13078
- WINE, C. B.  
Optimal sizing of solar collectors by the method  
of relative areas 21 p0066 A79-14263
- WINICK, J.  
Molten-carbonate CO<sub>2</sub> concentrator - Preliminary  
experiments [ASME PAPER 78-ENAS-2] 21 p0048 A79-12551
- WINSOR, H. V.  
Optics in adverse environments; Proceedings of the  
Seminar, San Diego, Calif., August 25, 26, 1977  
21 p0044 A79-12037
- WINSTON, R.  
Optics applied to solar energy conversion;  
Proceedings of the Seminar, San Diego, Calif.,  
August 23, 24, 1977 21 p0042 A79-11965
- A compound parabolic concentrator for a high  
temperature solar collector requiring only  
twelve tilt adjustments per year 21 p0134 A79-17439
- Compound parabolic concentrators with  
non-evacuated receivers - Prototype performance  
and a larger scale demonstration in a school  
heating system 21 p0134 A79-17440
- High temperature solar collector of optimal  
concentration - Non-focusing lens with secondary  
concentrator 21 p0135 A79-17448
- WINTERBONE, D. E.  
A multivariable controller for an automotive gas  
turbine [ASME PAPER 79-GT-73] 22 p0307 A79-30537
- WIRGIN, A.  
Theoretical and experimental analysis of a latent  
heat storage system 21 p0121 A79-17323
- On the use of grating or mesh selective filters to  
increase the efficiency of flat plate solar  
collectors 21 p0127 A79-17380
- Prediction of the behavior of a solar storage  
system by means of recurrent stochastic models  
22 p0258 A79-23295
- WISE, D. L.  
Engineering analysis of in situ liquefaction of coal  
21 p0032 A79-10521
- WISE, J. J.  
Novel technology for conversion of methanol and  
synthesis gas to hydrocarbons 21 p0007 A79-10064
- WITCOWSKI, E. D.  
Alternate aircraft fuels prospects and operational  
implications 21 p0066 A79-14138
- WITHAM, C. L.  
Preliminary environmental assessment of energy  
conversion processes for agricultural and forest  
product residues, volume 1 [PB-281189/1] 21 p0178 A79-10574
- WITHERSPOON, P. A.  
Underground aquifer storage of hot water from  
solar energy collectors 21 p0120 A79-17317
- WITHROW, J.  
A mass and energy balance of a Wellman-Galusha  
gasifier 22 p0283 A79-26467
- WOBKER, U.  
Experimental results and concepts of different  
solar concentrators 21 p0057 A79-13643
- WOELL, R. L.  
Data acquisition using a modular data logger  
21 p0088 A79-15832
- WOERNER, L.  
The production of solar cell grade silicon from  
bromosilanes [NASA-CR-158362] 22 p0358 A79-20482
- WOESSNER, G.  
Construction and test of a test apparatus for  
determining the efficiency of solar collectors  
with the ASP-test method 21 p0134 A79-17436
- WOHLGEMUTH, J. H.  
Vertical junction silicon solar cell  
21 p0001 A79-10013
- WOLF, D.  
Liquid metal heat pipes for the central solar  
receiver 21 p0014 A79-10114
- Development of small solar power plants for rural  
areas in India 21 p0141 A79-17502
- WOLF, H.  
Analysis and evaluation of process and equipment  
in tasks 2 and 4 of the Low Cost Solar Array  
project [NASA-CR-158089] 22 p0335 A79-16378
- WOLF, R. A.  
An operating 200 kW horizontal axis wind turbine  
22 p0240 A79-20829
- An operating 200-kW horizontal axis wind turbine  
[NASA-TM-79034] 22 p0333 A79-16357
- WOLFE, D. A.  
Marine biological effects of OCS petroleum  
development [PB-288935/0] 22 p0344 A79-17374
- WOLFE, H. G.  
Historical and projected power requirements  
21 p0169 A79-10125
- WOLFE, S. B.  
Characteristics of  
electron-cyclotron-resonance-heated tokamak  
power reactors 22 p0292 A79-27885
- WOLFE, W. P.  
Some effects of flow curvature on the performance  
of Barrius wind turbines [AIAA PAPER 79-0112] 21 p0156 A79-19538
- WOLFF, B.  
Wind energy 22 p0287 A79-27327
- WOLFF, C. B.  
Technique and instrumentation for measuring the  
performance of integrated solar heating/cooling  
systems 21 p0087 A79-15830
- WOLK, R. H.  
Coal liquefaction - Status and new directions  
21 p0007 A79-10062
- VOLKEN, G., JR.  
Magnetically confined plasma solar collector  
21 p0109 A79-16617



- VOLTER, J. G.**  
Current state-of-the-art of electrochemical batteries from a users point of view  
21 p0071 A79-14681
- WON, D. J.**  
Run duration analysis of surface wind speeds for wind energy application  
22 p0287 A79-27345
- WOOD, B.**  
The application of ASHRAE Standard 93-77 to the thermal performance testing of air solar collectors  
21 p0102 A79-16423
- WOOD, B. D.**  
Performance testing of a three ton solar absorption chiller  
[AIAA PAPER 78-1757] 21 p0060 A79-13858  
Results and analysis of a round robin test program for liquid-heating flat-plate solar collectors  
22 p0295 A79-28356
- WOOD, B. E.**  
Augmented solar energy collection using different types of planar reflective surfaces - Theoretical calculations and experimental results  
22 p0242 A79-21166  
Augmented solar energy collection using various planar reflective surfaces: Theoretical calculations and experimental results  
[LA-7041] 21 p0185 A79-11494
- WOOD, D. O.**  
Annual review of energy. Volume 3  
21 p0074 A79-14718
- WOOD, J. R.**  
Energy scenarios: Supplementary studies  
[WP-23292] 21 p0211 A79-13543
- WOODBRIDGE, D. D.**  
Ocean energy unlimited  
21 p0095 A79-15908
- WOODCOCK, G. R.**  
Solar Power Satellite systems definition  
22 p0326 A79-31920
- WOODCOCK, K. E.**  
Catalytic coal gasification exploratory research program  
21 p0030 A79-10247
- WOODS, R. L.**  
An air-modulated fluidic fuel-injection system  
[ASME PAPER 78-WA/DSC-21] 21 p0159 A79-19766
- WOOLIAN, V. J.**  
Solar energy R&D in Iran - The approach and the philosophy  
21 p0117 A79-17284  
Solar thermal electrical power plants for Iran  
22 p0295 A79-28352
- WOOLLEY, R. L.**  
Progress report on hydrogen production and utilization for community and automotive power  
21 p0016 A79-10132
- WORKHOVEN, R. H.**  
Concentrating solar collector test results, Collector Module Test Facility  
[SAND-78-0815] 21 p0208 A79-13522  
Performance testing of the Rexcel Parabolic Trough Solar Collector  
[SAND-76-0381] 21 p0221 A79-14569
- WORRELL, W. L.**  
Electrochemical determinations of the chemical potential and diffusivity of sodium in Na/x/TaS<sub>2</sub> at 300 K  
21 p0040 A79-11830
- WORSTELL, M. H.**  
Torque ripple in a vertical axis wind turbine  
21 p0029 A79-10239
- WORTHINGTON, P. J.**  
Composite material flywheels for energy storage on electricity supply systems  
22 p0241 A79-20852
- WRIGHT, B.**  
Field performance of certain selective and neutral surfaces in solar collectors  
21 p0131 A79-17417
- WRIGHT, G. W.**  
Comparative cost analyses: Total flow vs other power conversion systems for the Salton Sea Geothermal Resource  
[UCRL-52589] 22 p0342 A79-17337

- WRIGHT, I. G.**  
State of the art and science report on design of alloys resistant to high-temperature corrosion-erosion in coal conversion environments  
[EPRI-PP-557] 21 p0200 A79-13149
- WRIGHT, C.**  
Development of an improved high efficiency thin silicon solar cell  
[NASA-CR-158172] 22 p0354 A79-19459
- WRIGHT, C. Y.**  
Vertical junction silicon solar cell  
21 p0001 A79-10013
- WU, H. Y.**  
Attitude and pointing control system for the microwave antenna of the solar power satellite  
21 p0113 A79-16739
- WU, S. T.**  
A liquid solar energy storage tank model. I - Formulation of a mathematical model  
22 p0267 A79-24314
- WU, Y. C.**  
Solar receiver performance of point focusing collector system  
[ASME PAPER 78-WA/SOL-5] 21 p0163 A79-19838
- WU, Y. C. L.**  
Design studies and trade-off analyses for a superconducting magnet/MHD power generator system  
21 p0017 A79-10142
- WUNG, T. Y.**  
Thermal analysis of black liquid cylindrical parabolic collector  
22 p0295 A79-28354
- WUTKE, G. H.**  
Point-contact conduction-cooling technique and apparatus for cryogenic laser fusion pellets  
21 p0085 A79-15335

## Y

- YADAV, K. S.**  
Design and fabrication of silicon solar cells for concentrated light  
21 p0124 A79-17352
- YAFFEE, P.**  
Baltimore applications project  
[NASA-TN-79667] 22 p0351 A79-18815
- YAGI, S.**  
A new combustion system in the three-valve stratified charge engine  
[SAE PAPER 790439] 22 p0316 A79-31376
- YAKHOT, A.**  
Attenuating the transverse edge effect in MHD generators  
21 p0063 A79-13985
- YAMADAYA, T.**  
Hydride formation of C14-type Ti alloy  
22 p0250 A79-21701
- YAMAGISHI, T.**  
A calculation of linear magnetic liner fusion reactor performance  
21 p0018 A79-10153
- YANABOTO, K.**  
Development status of rotary engine at Toyo Kogyo  
22 p0329 A79-15964
- YANABOTO, T.**  
Efficiency studies about Daihatsu engine/electric hybrid system  
[SAE PAPER 790013] 22 p0314 A79-31352
- YANASAKI, H.**  
Experimental studies of a linear MHD generator with fully ionized seed  
22 p0238 A79-20796
- YANAZAKI, K.**  
200-kv Blumlein transmission line for ultrafast toroidal theta-pinch  
22 p0297 A79-28917
- YANAGIDA, T.**  
The use of heat exchangers with THERMOEXCEL's tubing in ocean thermal energy power plants.  
[ASME PAPER 78-WA/HT-65] 21 p0162 A79-19825
- YANG, E.**  
Organic geochemical studies on kerogen precursors in recently deposited algal mats and oozes  
21 p0031 A79-10419
- YANG, R. T.**  
A regenerative process for fluidized-bed combustion of coal with lime additives  
22 p0297 A79-28984

PERSONAL AUTHOR INDEX

ZAKHIDOV, R. A.

- YANG, W. C.  
Circulating-bed boiler concepts for steam and power generation 21 p0008 A79-10071
- YAO, B.  
A thermodynamic study of heating with geothermal energy [ASME PAPER 77-WA/ENER-1] 21 p0030 A79-10253
- YAO, W. P.  
Advanced secondary batteries for electric vehicle propulsion [CONF-780426-2] 21 p0186 W79-11508
- YAROSH, H. H.  
Structuring a small national or state solar energy program 22 p0262 A79-23751
- YASINSKY, J. B.  
Advances in fluidized bed gasification process development 21 p0145 A79-17633
- YATTE, J. C.  
Reversible thermoelectric power conversion of energy fluctuations 22 p0261 A79-23619
- YAWS, C. L.  
Electricity from sunlight 21 p0065 A79-14116  
Process feasibility study in support of silicon material task 1 [NASA-CR-158034] 21 p0219 W79-14541
- YEH, L.-S. R.  
Iron oxide semiconductor electrodes in photoassisted electrolysis of water 21 p0057 A79-11781
- YEH, Y. C. H.  
Optimum antireflection coating for Antireflection-coated Metal-Oxide-Semiconductor /AMOS/ solar cells 21 p0042 A79-11955
- YEKUTIELI, G.  
High reliability contacts for miniature thermoelectric converters 21 p0027 A79-10228  
Solar furnace type high power density thermoelectric generator 21 p0027 A79-10229  
Efficient Fresnel lens for solar concentration 22 p0285 A79-26816
- YELLOTT, J. I.  
History of solar energy applications - Solar energy yesterday, today and tomorrow 21 p0089 A79-15852  
The application of ASHRAE Standard 93-77 to the thermal performance testing of air solar collectors 21 p0102 A79-16423
- YEN, J. Y.  
Some flow analyses for Tornado-type wind turbines 22 p0279 A79-26181  
Some recent developments in wind and ocean power systems 22 p0303 A79-29797
- YENER, Y.  
Thermal storage of solar energy 21 p0103 A79-16459
- YERAZUNIS, S.  
Development and application of techniques to evaluate cogeneration impacts 22 p0303 A79-29795
- YEROSHENKO, V. H.  
Some heat transfer and hydrodynamic problems associated with superconducting cables (SPTL) [NASA-TN-79023] 21 p0226 W79-15267
- YESIL, O.  
Blackbody optical pumping of carbon dioxide laser mixtures 21 p0203 W79-13343
- YIN, H. C.  
Analysis of alternatives for U.S. international cooperation in solar energy 21 p0116 A79-17277
- YONAS, G.  
Fusion power with particle beams 21 p0034 A79-11121
- YOO, H. I.  
Silicon solar cell process development, fabrication and analysis [NASA-CR-158363] 22 p0359 W79-20485
- YOON, H.  
Feasible operating regions for moving bed coal gasification reactors 22 p0297 A79-28983
- YORTSOS, Y. C.  
Analytical modelling of oil recovery by steam injection 22 p0358 W79-20434
- YOSHIZAWA, S.  
Energy storage by the use of high temperature electrochemical systems 21 p0148 A79-17992
- YOUNG, J.  
Coal liquefaction support studies. Task 1: Heat of reaction of hydrogen with coal slurries. Task 2: Heat transfer coefficient [ANL/CEH/FE-77-5] 21 p0216 W79-14242
- YOUNG, L. E.  
Status of wraparound contact solar cells and arrays 21 p0001 A79-10014
- YOUNG, H. P.  
Numerical computation of the loss coefficients for evacuated cylindrical collector receiver tubes [ASME PAPER 78-WA/SOL-3] 21 p0162 A79-19836
- YOUNGER, P. R.  
Integral assembly of photovoltaic arrays using glass 22 p0241 A79-20883
- YOUNGSEBLOOD, S. B.  
Solar energy for industrial process steam 22 p0267 A79-24315
- YU, W. C.  
Environmental assessment for residual oil utilization [PB-286982/4] 22 p0336 W79-16446
- YUDOW, B.  
Alternative forms of energy transmission from OTEC plants 21 p0141 A79-17505  
Feasibility study of transporting offshore OTEC-produced energy to shore by thermal media. Project 8980 [DSE/2426-19] 21 p0174 W79-10535
- YUHARA, K.  
Infrared remote sensing on geothermal areas by helicopter 22 p0256 A79-22620
- YUILL, G. K.  
Economic design of a solar domestic water heating system 22 p0321 A79-31438
- YUNG, C. S.  
A two-dimensional thermal analysis of a new high-performance tubular solar collector 22 p0352 W79-19060

Z

- ZABRANSKY, Z.  
Influence of composition on the activity of tungsten carbide gas diffusion hydrogen electrodes 22 p0245 A79-21482
- ZAIKITS, S. L.  
Problems in the development of high-service-life capacitive accumulators 22 p0243 A79-21249
- ZAITSEVA, A. K.  
Spectral characteristics of photoconverters with nonuniform effect distribution in the base 21 p0053 A79-13289  
New models of solar cells and prospects for their optimization 21 p0166 A79-20346
- ZAJAC, G.  
Microstructure dependence of the optical properties of solar-absorbing black chrome 22 p0256 A79-22858
- ZAKHARKO, I. A.  
Vaporization of drops of a melt of potassium carbonate in a medium of combustion products 21 p0167 A79-20411
- ZAKHIDOV, R. A.  
General principles of multielement concentrating system design 21 p0054 A79-13291  
Composite heliostats of large solar plants 21 p0166 A79-20350  
Accelerated tests for coatings 22 p0296 A79-28668

- ZAKKAY, V.**  
Heat exchanger designs for coal-fired fluidized beds  
21 p0009 A79-10079  
Recent developments in pressurized fluidized bed  
coal combustion research  
[AIAA PAPER 79-0190] 21 p0157 A79-19589
- ZAKS, M. B.**  
Characteristics of silicon photoconverters with  
inversion layer 21 p0166 A79-20349  
Analysis of the characteristics of silicon  
photoconverters in the 100-400 K temperature range  
21 p0167 A79-20361
- ZANCHINI, E.**  
A contribution to evaluation of flat-plate solar  
collectors performance 21 p0133 A79-17427
- ZANDERS, D. L.**  
Particulate control mobile test units: Third  
year's operation  
[PB-283657/5] 21 p0178 N79-10603
- ZAR, J.**  
Design of superconducting magnets for full-scale  
MHD generators 21 p0084 A79-15306
- ZATELEPIN, V. N.**  
Effect of force field nonuniformity on flow in an  
MHD channel 21 p0101 A79-16365
- ZAVITSANOS, P. D.**  
Coal desulfurization using microwave energy  
[PB-285880/1] 21 p0216 N79-14243
- ZAWORSKI, R. J.**  
Solar pond stability experiments 21 p0042 A79-11878
- ZEITLIN, B. A.**  
Conductor for LASL 10-MW hr superconducting energy  
storage coil 21 p0085 A79-15309
- ZEITNER, E. J., JR.**  
High performance lithium/iron disulfide cells  
21 p0010 A79-10087
- ZELDIN, B.**  
Parametric study of two planar high power flexible  
solar array concepts  
[NASA-CR-157841] 21 p0205 N79-13501
- ZELENER, B. V.**  
The electric conductivity of a plasma of  
combustion products of hydrocarbon fuels with  
alkali impurity 21 p0167 A79-20415
- ZEMBRZUSKI, J.**  
Optimization method of isotopic thermoelectric  
microgenerator geometry 22 p0260 A79-23613
- ZENKEVICH, B. V.**  
Superconducting magnets 21 p0105 A79-16485
- ZEREN, P.**  
Design of a freon jet pump for use in a solar  
cooling system  
[ASME PAPER 78-WA/SOL-15] 21 p0164 A79-19847
- ZHELIN, V. A.**  
Comparison of results of calculation of flow in an  
MHD generator with experimental data obtained on  
the U-25 device 22 p0306 A79-30392
- ZHERBTSOV, V. A.**  
Contribution to the theory of the pulsed mode of  
operation of the thermionic energy converter. II  
22 p0246 A79-21542
- ZHIDKOVA, E. V.**  
Spectral characteristics of photoconverters with  
nonuniform defect distribution in the base  
21 p0053 A79-13289
- ZHILINSKII, A. P.**  
Investigation of the Hall effect in a discharge  
with a rotational electric field 22 p0246 A79-21532
- ZHOLUDOV, I. A. S.**  
Stability of combustion in the combustion chamber  
of an MHD generator 21 p0049 A79-12691  
Development of the combustion chamber of an  
experimental MHD generator 22 p0327 A79-32105
- ZHUKOVSKII, V. G.**  
Effect of the magnetic configuration of the  
poloidal diverter on the plasma in the T-12  
finger-ring tokamak 22 p0244 A79-21429
- ZIEGENBEIN, B.**  
Design, operation and performance of the BBC Solar  
House 21 p0137 A79-17462
- ZIMMERMAN, A. H.**  
A state of charge monitor for sealed lead-acid cells  
[ATR-78(8114)-2] 21 p0220 N79-14558
- ZIMMERMAN, F. W.**  
Potential producibility and recovery of natural  
gas from geopressed aquifers of the Cenozoic  
sediments of the Gulf Coast Basin  
[PE-2025-3] 21 p0192 N79-11607
- ZIMMERMAN, N.**  
An assessment of mercury emissions from fossil  
fueled power plants  
[PB-285227/5] 21 p0213 N79-13592
- ZIMMERMAN, W. F.**  
Mini-Brayton heat source assembly development  
[NASA-CR-159447] 21 p0196 N79-12554
- ZIMMERMAN, K. J.**  
New design verification aspects of large flexible  
solar arrays  
[IAP PAPER 78-217] 21 p0035 A79-11298
- ZIMONT, V. L.**  
Combustion of hydrogen in a supersonic flow in a  
channel in the presence of a pseudodiscontinuity  
22 p0324 A79-31845
- ZINN, K. G.**  
Augmented solar energy collection using different  
types of planar reflective surfaces -  
Theoretical calculations and experimental results  
22 p0242 A79-21166  
Augmented solar energy collection using various  
planar reflective surfaces: Theoretical  
calculations and experimental results  
[LA-7041] 21 p0185 N79-11494
- ZINNEBERG, T. E.**  
Observation of voltage fluctuations in a  
Superconducting Magnet during MHD power generation  
22 p0235 A79-20531
- ZIPKIN, M. A.**  
Making turbofan engines more energy efficient  
[ASME PAPER 78-GT-198] 21 p0033 A79-10818
- ZITSOW, U.**  
Steam generator and turbomachines 21 p0106 A79-16489
- ZLATANOVIC, M.**  
Performance of a closed-cycle MHD generator with  
molecular impurities 22 p0283 A79-26524
- ZONDERVAN, K. L.**  
Dynamic computer simulation of the DOE 10 MW solar  
thermal pilot plant  
[AIAA PAPER 78-1752] 21 p0060 A79-13854
- ZORZI, E. S.**  
A status of the 'Alpha-ply' composite flywheel  
concept development 22 p0241 A79-20843
- ZOSCHAK, B. J.**  
Heat pipe central solar receiver gas turbine plant  
21 p0022 A79-10178
- ZOTOV, I. L.**  
Cryogenic technology and superconductivity in  
controlled fusion 22 p0311 A79-31003
- ZUKAKISHVILI, G. G.**  
Plasma behavior near the neutral line between  
parallel currents 22 p0324 A79-31754
- ZUKAKISHVILI, L. M.**  
Plasma behavior near the neutral line between  
parallel currents 22 p0324 A79-31754
- ZUMDIECK, J. F.**  
Energy exchanger technology applied to laser  
heated engines 21 p0110 A79-16631
- ZVIAGINA, K. N.**  
Study of photoelectric characteristics of  
photocells made from high-resistivity silicon  
22 p0296 A79-28666

PERSONAL AUTHOR INDEX

ZVIRIN, Y.

ZVIRIN, Y.

Experiments with a flat plate solar water heating  
system in thermosyphonic flow

22 p0262 A79-23755

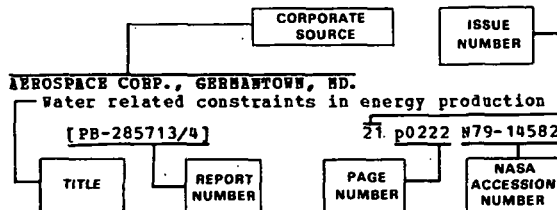
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# CORPORATE SOURCE INDEX

ENERGY / A Continuing Bibliography (Issue 22)

JULY 1979

## Typical Corporate Source Index Listing



The title of the document is used to provide a brief description of the subject matter. The issue, page number and NASA or AIAA accession number are included in each entry to assist the user in locating the abstract in the abstract section of an individual supplement of *Energy*. If applicable, a report number is also included as an aid in identifying the document.

## A

### ADVISORY GROUP FOR AEROSPACE RESEARCH AND DEVELOPMENT, BEUILLY-SUR-SEINE (FRANCE).

The AGARD propulsion and energetics panel, 1952-1977

[AGARD-AR-111] 22 p0337 N79-16848

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Aircraft Engine Future Fuels and Energy Conservation

[AGARD-LS-96] 21 p0201 N79-13192

### AEROCHEM RESEARCH LABS., INC., PRINCETON, N. J.

Development of a model and computer code to describe solar grade silicon production processes

[NASA-CR-158037] 21 p0219 N79-14555

### AERONAUTICAL RESEARCH LABS., MELBOURNE (AUSTRALIA).

Tests of Wisconsin S12D engine running on natural gas with addition of carbon dioxide

[AD-A058486] 22 p0339 N79-17230

### AEROSPACE CORP., EL SEGUNDO, CALIF.

High efficiency low cost solar cell power

21 p0048 N79-12471

Historical and projected power requirements

21 p0169 N79-10125

A state of charge monitor for sealed lead-acid cells

[ATR-78(8114)-2] 21 p0220 N79-14558

Statement of Ivan Bekey, Director of Advanced Mission Studies, Aerospace Corporation

21 p0224 N79-15107

### AEROSPACE CORP., GERMANTOWN, MD.

Water related constraints in energy production

[PB-285713/4] 21 p0222 N79-14582

### AEROSPATIALE ETABLISSEMENT DES MUREAUX (FRANCE).

Development of a satellite flywheel family

operating on one active axis magnetic bearings

22 p0366 N79-21392

### AEROTHERM ACUREX CORP., MOUNTAIN VIEW, CALIF.

Measurement of high-temperature, high-pressure processes

[PB-284041/1] 21 p0195 N79-12424

### AGRICULTURAL AND TECHNICAL COLL. OF NORTH CAROLINA, GREENSBORO.

Material growth and characterization directed toward improving III-V heterojunction solar cells

[NASA-CR-158476] 22 p0367 N79-21543

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Phase one/base data for the development of energy performance standards for new buildings: Data analysis

[PB-286901/4] 22 p0331 N79-16148

Phase one/base data for the development of energy performance standards for new buildings: Sample design

[PB-286903/0] 22 p0331 N79-16150

Phase one/base data for the development of energy performance standards for new buildings: Climatic classification

[PB-286900/6] 22 p0336 N79-16497

Phase one/base data for the development of energy performance standard for new buildings. Task report: Building classification

[PB-286904/8] 22 p0355 N79-19468

### AIR FORCE ACADEMY, COLO.

The development of a laser Doppler velocimetry system for unsteady separated flow research: Preliminary results

[AD-A061724] 22 p0352 N79-19305

### AIR FORCE AERO PROPULSION LAB., WRIGHT-PATTERSON AFB, OHIO.

Military needs for orbital power

21 p0169 N79-10127

Evaluation of future jet fuel combustion characteristics

[AD-A060218] 21 p0216 N79-14231

Some fatigue characteristics of nickel battery plaque

[AD-A060370] 21 p0230 N79-15415

### AIR FORCE INST. OF TECH., WRIGHT-PATTERSON AFB, OHIO.

The application of optimal control theory hybrid electric transit systems

[AD-A059365] 21 p0220 N79-14559

Development of an Air Force facilities energy information system

[AD-A059309] 21 p0223 N79-14918

### AIRRESEARCH MFG. CO., LOS ANGELES, CALIF.

Study of heat engine/flywheel: Hybrid propulsion configuration with electrical transmission system. Phase 2: Design definition

[ALO-41/2] 21 p0185 N79-11493

### AIRRESEARCH MFG. CO., PHOENIX, ARIZ.

Mini-BRU/BIPS 1300 watt (sub) dynamic power conversion system development: Executive summary

[NASA-CR-159440] 21 p0173 N79-10526

Ceramic technology readiness program

[PE-2664-7] 21 p0180 N79-11223

### AIRRESEARCH MFG. CO., TORRANCE, CALIF.

Study of flywheel energy storage Volume 1: Executive summary

[PB-282652/7] 21 p0176 N79-10555

Study of flywheel energy storage. Volume 2: Systems analysis

[PB-282653/5] 21 p0176 N79-10556

Study of flywheel energy storage. Volume 3: System mechanization

[PB-282654/3] 21 p0177 N79-10557

Study of flywheel energy storage. Volume 4: Life-cycle costs

[PB-282655/0] 21 p0177 N79-10558

Study of flywheel energy storage. Volume 5: Vehicle tests

[PB-282656/8] 21 p0177 N79-10559

Prototype solar heating and cooling systems

[NASA-CR-150828] 21 p0196 N79-12552

Wayside energy storage summary. Volume 1: Summary

[DOT-TSC-PRA-79-7-1-VOL-1] 22 p0370 N79-21563

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Analysis of data user's needs for performance  
evaluation of solar heating and cooling systems  
[NASA-CR-150831] 21 p0087 A79-15827

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Development of surfaces optically suitable for  
flat solar panels  
[NASA-CR-150831] 21 p0173 N79-10522

## ALABAMA UNIV. IN HUNTSVILLE.

Cost analysis and optimization study for solar  
heating and cooling systems, Stillwater,  
Minnesota and Newcastle, Pennsylvania  
[NASA-CR-161201] 22 p0358 N79-20478  
Cost analysis and optimization study for solar  
heating and cooling systems  
[NASA-CR-161200] 22 p0360 N79-20499

## ALL-UNION SCIENTIFIC RESEARCH INST. OF OIL

## REFINING, MOSCOW (USSR).

Demetalization catalyst tests on heavy residual  
oils  
[PB-285937/9] 21 p0232 N79-15864

## ALLIED CHEMICAL CORP., IDAHO FALLS, IDAHO.

Liquid-fluidized-bed heat exchanger flow  
distribution models  
[ICP-1151] 22 p0369 N79-21559

## AMERICAN GAS ASSOCIATION, INC., ARLINGTON, VA.

Direction of gas supply research in the US  
22 p0340 N79-17320

## AMERICAN UNIV., WASHINGTON, D. C.

The preparation of some novel electrolytes:  
Synthesis of partially fluorinated alkane  
sulfonic acids as potential fuel cell  
electrolytes  
[AD-A056278] 21 p0184 N79-11483  
Definition of chemical and electrochemical  
properties of a fuel cell electrolyte  
[AD-A058795] 21 p0206 N79-13503

## ARGONNE NATIONAL LAB., ILL.

National coal utilization assessment: An  
integrated assessment of increased coal use in  
the midwest: Impacts and constraints, volume 1  
[ANL/AA-11-VOL-1-DRAFT] 21 p0174 N79-10537

Biomimetic approach to solar energy conversion:  
Artificial photosynthesis  
[CONF-780222-5] 21 p0186 N79-11506

Advanced secondary batteries for electric  
vehicle propulsion  
[CONF-780426-2] 21 p0186 N79-11508

Integrating technologies to produce energy  
conservation  
[CONF-780109-6] 21 p0189 N79-11541

Experimental two-phase liquid-metal  
magnetohydrodynamic generator program  
[AD-A059240] 21 p0197 N79-12564

Environmental control implications of generating  
electric power from coal. Appendix A, part 2:  
Coal preparation and cleaning assessment study  
appendix  
[ANL/ECT-3-APP-A-PT-2] 21 p0213 N79-13571

Coal liquefaction support studies. Task 1:  
Heat of reaction of hydrogen with coal  
slurries. Task 2: Heat transfer coefficient  
[ANL/CEN/PE-77-5] 21 p0216 N79-14242

MHD balance of plant technology project  
[ANL-MHD-78-7] 22 p0361 N79-20500

Parametric study of the performance of a CDIF  
1-B coal-fired MHD generator  
[ANL-MHD-79-3] 22 p0361 N79-20503

Technical support for open-cycle MHD program  
[ANL-MHD-78-8] 22 p0361 N79-20507

A biologist's manual for the evaluation of  
impacts of coal-fired power plants on fish,  
wildlife and their habitats:  
[PB-291330/9] 22 p0373 N79-21679

## ARIZONA UNIV., TUCSON.

Outlook for world oil into the 21st century with  
emphasis on the period to 1990  
[EPRI-EA-745] 21 p0181 N79-11454

Optical design of a solar collector for the  
advanced solar thermal electric  
conversion/process heat program  
[Y/SUB-77/14261] 21 p0209 N79-13528

Solar energy, water, and industrial systems in  
arid lands: Technological overview and  
annotated bibliography  
[PB-285129/3] 21 p0211 N79-13549

## CORPORATE SOURCE INDEX

ARMY COMMAND AND GENERAL STAFF COLL., PORT  
LEAVENWORTH, KANSAS.

The department o. Defense's alternate energy  
policy  
[AD-A058200] 21 p0197 N79-12563

ARMY CONSTRUCTION ENGINEERING RESEARCH LAB.,  
CHAMPAIGN, ILL.

Design of solar heating and cooling systems  
[AD-A062719] 22 p0363 N79-20522

## ARMY ELECTRONICS COMMAND, PORT HONNOUTH, N. J.

Improved anodes for liquid hydrocarbon fuel cell  
[AD-A058456] 21 p0206 N79-13504

ARMY FACILITIES ENGINEERING SUPPORT AGENCY, PORT  
BELVOIR, VA.

Energy utilization survey pamphlet for buildings  
[AD-A062930] 22 p0371 N79-21624

ARMY MOBILITY EQUIPMENT RESEARCH AND DEVELOPMENT  
COMMAND, PORT BELVOIR, VA.

High energy metal hydride fuel cell power source  
[AD-A056491] 21 p0184 N79-11485

## ARTECH CORP., FALLS CHURCH, VA.

Thermal energy storage subsystems  
[NASA-CR-150812] 21 p0172 N79-10517

## ASL ENGINEERING, GOLETA, CALIF.

Environmentally induced cracking of natural gas  
and liquid pipelines. Volume 2: Appendices A  
and B  
[PB-282924/0] 21 p0181 N79-11446

Environmentally induced cracking of natural gas  
and liquid pipelines. Volume 1: Technical  
report  
[PB-282923/2] 21 p0181 N79-11447

## ATOMIC ENERGY BOARD, PRETORIA (SOUTH AFRICA).

Nuclear power today and tomorrow  
22 p0340 N79-17317

## AUDI NSU AUTO UNION A.G., NECKARSULM (WEST GERMANY).

Update of development on the new Audi NSU rotary  
engine generation  
22 p0329 N79-15965

Review of the Rhein-Plugzeugbau Wankel powered  
aircraft program  
22 p0329 N79-15966

## AUSTRIAN SOLAR AND SPACE AGENCY, VIENNA.

Proposal for a representation of the  
quasisteady-state performance of flat-plate  
collectors  
[ASSA-SE-B21/77] 22 p0349 N79-18461

## AVCO-EVERETT RESEARCH LAB., MASS.

Engineering test facility conceptual design,  
part 1  
[FE-2614-2-PT-1] 22 p0369 N79-21560

Engineering test facility conceptual design,  
part 2  
[FE-2614-2-PT-2] 22 p0369 N79-21561

## AXIONATIX, LOS ANGELES, CALIF.

Microwave systems analysis, solar power satellite  
[NASA-CR-160091] 22 p0337 N79-16892

## B

## BATTELLE COLUMBUS LABS., OHIO.

Magnetically confined plasma solar collector  
21 p0109 A79-16617

Methods for the photochemical utilization of  
solar energy  
21 p0111 A79-16641

State of the art and science report on design of  
alloys resistant to high-temperature  
corrosion-erosion in coal conversion  
environments  
[EPRI-PP-557] 21 p0200 N79-13149

EPA program conference report: Coal cleaning,  
an option for Increased Coal Utilization  
[PB-288223/1] 22 p0344 N79-17378

Earth orbital assessment of solar electric and  
solar sail propulsion systems  
[NASA-CR-158167] 22 p0345 N79-17898

Preliminary environmental assessment of biomass  
conversion to synthetic fuels  
[PB-289775/9] 22 p0365 N79-21224

## BATTELLE MEMORIAL INST., COLUMBUS, OHIO.

Combustion of hydrothermally treated coals  
[PB-287521/9] 22 p0338 N79-17025

## BATTELLE PACIFIC NORTHWEST LABS., RICHLAND, WASH.

Chemical production from waste carbon monoxide:  
Its potential for energy conservation  
[BNWL-2137] 21 p0170 N79-10179

## CORPORATE SOURCE INDEX

## BUREAU OF MINES,

- Initial assessment: Electromagnetic compatibility aspects of proposed SPS Microwave Power Transmission System (MPTS) operations  
[PNL-2482] 21 p0202 N79-13252
- Preliminary results of a field experiment to characterize wind flow through a vertical plane  
[PNL-2518] 21 p0203 N79-13322
- Siting handbook for small wind energy conversion systems  
[PNL-2521] 21 p0209 N79-13527
- Analysis of federal incentives used to stimulate energy production  
[PNL-2410] 21 p0210 N79-13539
- Stored energy calculation: The state of the art  
[PNL-2581] 21 p0210 N79-13541
- Catalyst development program for hydrodesulfurization and liquefaction of coal to produce clean boiler fuels  
[PE-2321-12] 21 p0216 N79-14240
- Measured air flow rates through microorifices and flow prediction capability  
[PB-286868/5] 21 p0217 N79-14344
- Wind characteristics program element  
[PNL-2545] 22 p0356 N79-19568
- Development, characterization and evaluation of materials for open cycle MHD  
[PNL-2004-9] 22 p0361 N79-20504
- Wind direction change criteria for wind turbine design  
[PNL-2531] 22 p0361 N79-20506
- Development, characterization and evaluation of materials for open cycle MHD  
[PNL-2004-8] 22 p0369 N79-21557
- BEAM ENGINEERING, INC., SUNNYVALE, CALIF.  
Enhanced solar energy options using earth-orbiting mirrors  
21 p0019 A79-10162
- Space reflector technology and its system implications  
[AIAA PAPER 79-0545] 22 p0273 A79-25852
- BECHTEL CORP., SAN FRANCISCO, CALIF.  
Design of low-cost structures for photovoltaic arrays. Task 1: Survey of array structural characteristics  
[SAND-78-7021] 21 p0206 N79-13509
- Environmental control implications of generating electric power from coal. Appendix A, part 2: Coal preparation and cleaning assessment study appendix  
[ANL/ECT-3-APP-A-PT-2] 21 p0213 N79-13571
- BECHTEL INTERNATIONAL CORP., SAN FRANCISCO, CALIF.  
Structural cost optimization of photovoltaic central power station modules and support structure  
[ASME PAPER 79-SOL-17] 22 p0309 A79-30551
- BIPHASE ENERGY SYSTEMS, INC., SANTA MONICA, CALIF.  
Demonstration of a rotary separator for two-phase brine and steam flows  
[TID-28519] 22 p0365 N79-21309
- BLALOCK (S. D., JR.), KINGSPORT, TENN.  
Use of waste heat from thermal electric power plants and nuclear power plants to heat greenhouses  
[ORNL-TR-4483] 21 p0221 N79-14574
- BOEING AEROSPACE CO., SEATTLE, WASH.  
From sunlight in space to 60 Hz on earth - The losses along the way  
21 p0003 A79-10027
- Electrical power loss from high-voltage power circuits through plasma leakage  
21 p0169 N79-10113
- Improved semiconductors for photovoltaic solar cells  
[DSE/2459-2] 21 p0221 N79-14577
- BOEING COMPUTER SERVICES, INC., SEATTLE, WASH.  
SINWEST - A simulation model for wind energy storage systems  
21 p0029 A79-10241
- BOEING COMPUTER SERVICES CO., FALLS CHURCH, VA.  
Integrated safeguards information system (ISIS), executive summary  
[PB-286869/3] 21 p0223 N79-14934
- BOEING ENGINEERING AND CONSTRUCTION, SEATTLE, WASH.  
Feasibility study of solar dome encapsulation of photovoltaic arrays  
[NASA-CR-158368] 22 p0367 N79-21545
- BOLT, BERANEK, AND NEWMAN, INC., CAMBRIDGE, MASS.  
Noise-control needs in the developing energy technologies  
[COO-4389-1] 21 p0213 N79-13569
- BRISTOL UNIV. (ENGLAND).  
The effect of maturation on the configuration of pristane in sediments and petroleum  
22 p0272 A79-25375
- BRITISH AEROSPACE DYNAMICS GROUP, BRISTOL (ENGLAND).  
Study on solar arrays for programmes leading from the extension of Spacelab towards space platforms  
[ESS/SS-878] 22 p0335 N79-16379
- BRITISH LIBRARY LENDING DIV., BOSTON SPA (ENGLAND).  
Electrolysis of zinc. Statistical model of the process parameters for an industrial cell  
[BLI-RTS-11317] 22 p0345 N79-17984
- The optimum voltage for batteries used in standby lighting systems  
[BLI-RTS-11512] 22 p0347 N79-18439
- The world balance for energy needs in view of year 2000: Development of the problem and areas involved, part 2  
[BLI-RISLEY-TR-3395-(9091.9P)] 22 p0347 N79-18442
- BROOKHAVEN NATIONAL LAB., UPTON, N. Y.  
Annual highlights of the energy technology programs  
[BNL-50799] 21 p0185 N79-11499
- Energy needs, uses, and resources in developing countries  
[BNL-50784] 21 p0185 N79-11500
- Energy situation in the Mid-Atlantic region  
[BNL-50703] 21 p0188 N79-11528
- ERDA's oceanographic program for the mid-Atlantic coastal region  
[BNL-24016] 21 p0192 N79-11641
- Analytical framework for the assessment of energy resource and technology options for developing countries  
[BNL-50800] 21 p0208 N79-13524
- Some measures of regional-industrial interfuel substitution potentials  
[BNL-24368] 21 p0208 N79-13525
- Energy systems studies program  
[BNL-50822] 21 p0209 N79-13526
- Brookhaven National Laboratory  
burner-boiler/furnace efficiency test project. Annual fuel use and efficiency reference manual: hydronic equipment  
[BNL-50816] 21 p0210 N79-13538
- Assessment of the solid waste impact of the National Energy Plan  
[BNL-50708] 21 p0213 N79-13572
- Energy use in Japan and the United States  
[BNL-23101] 21 p0221 N79-14578
- Methodology for modeling geothermal district heating for residential markets  
[BNL-50905] 22 p0361 N79-20502
- Economic impacts of a transition to higher oil prices  
[BNL-50871] 22 p0364 N79-20927
- The Brookhaven buildings energy conservation optimization model  
[BNL-50828] 22 p0370 N79-21564
- BROWN, BOVERI UND CIE, A.G., HEIDELBERG (WEST GERMANY).  
Development of high temperature fuel cell battery  
[BNPT-PB-T-77-17] 22 p0342 N79-17344
- Solar water heating  
[BNPT-PB-T-77-42] 22 p0349 N79-18457
- BUNDESMINISTERIUM FUER WISSENSCHAFT UND FORSCHUNG, VIENNA (AUSTRIA).  
Austrian 10KWE solar power plant. A project of the Federal Ministry for Science and Research  
22 p0349 N79-18460
- BUREAU OF MINES, COLLEGE PARK, MD.  
Antimony, arsenic, and mercury in the combustible fraction of municipal solid waste  
[PB-285196/2] 21 p0213 N79-13590
- BUREAU OF MINES, WASHINGTON, D. C.  
Projects to expand energy sources in the western states  
[PB-283706/0] 21 p0190 N79-11547
- Bureau of Mines research 1977. A summary of significant results in mining, metallurgy, and mineral economics  
[PB-284743/2] 21 p0217 N79-14521

## BURNS AND McDONNELL, KANSAS CITY, MO.

- Assessment of the potential of solar thermal  
small power systems in small utilities  
[NASA-CR-158093] 22 p0335 N79-16377
- BURNS AND ROE, INC., WOODBURY, N. Y.  
USAF terrestrial energy study. Volume 3, part  
1: Summary data display  
[AD-A061071] 22 p0342 N79-17341

## C

## CALIFORNIA ENERGY COMMISSION, SACRAMENTO.

- Conservation where it counts: Energy management  
systems  
[PB-289837/7] 22 p0372 N79-21628

## CALIFORNIA INST. OF TECH., PASADENA.

- Coal desulfurization by low-temperature  
chlorinolysis  
21 p0045 A79-12119
- Analytical modelling of oil recovery by steam  
injection  
22 p0358 N79-20434

## CALIFORNIA UNIV., BERKELEY.

- Organic geochemical studies on kerogen  
precursors in recently deposited algal mats  
and oozes  
21 p0031 A79-10419
- Geothermal Reservoir Engineering Management  
Program Plan (GRIMP Plan)  
[LBI-7000] 21 p0174 N79-10536
- Evaluation of the use of oxygen as oxidant in  
fossil fuel fired open cycle MHD-steam energy  
conversion processes  
22 p0353 N79-19444
- V-groove multijunction solar cells  
22 p0353 N79-19445
- Seismological investigations in geothermal regions  
22 p0356 N79-19506

## CALIFORNIA UNIV., BERKELEY. LAWRENCE BERKELEY LAB.

- Reliability of wind power from dispersed sites:  
A preliminary assessment  
[LBI-6889] 21 p0176 N79-10547
- National Geothermal Information Resource  
[LBI-7803] 21 p0187 N79-11515
- Definition of engineering development and  
research problems relating to the use of  
geothermal fluids for electric power  
generation and nonelectric heating  
[LBI-7025] 21 p0188 N79-11534
- Urbanism and energy in developing regions  
[LBI-7808] 21 p0189 N79-11540
- Geothermal emissions data base: Cerro Prieto  
geothermal field  
[UCID-4033] 21 p0204 N79-13480
- Energy conservation: Policy issues and end-use  
scenarios of savings potential. Part 1:  
Summary  
[LBI-7896] 22 p0341 N79-17329
- A computerized reporting and monitoring system  
for geothermal energy development  
[LBI-8483] 22 p0369 N79-21555
- CALIFORNIA UNIV., LIVERMORE. LAWRENCE LIVERMORE LAB.  
Computer modeling of automotive engine combustion  
[UCRL-80451] 21 p0181 N79-11412
- Design guide for shallow solar ponds  
[UCRL-52385] 21 p0185 N79-11497
- Evaluated physical properties data for materials  
used in energy storage systems  
[UCRL-81159] 21 p0189 N79-11536
- Mechanically rechargeable, metal-air batteries  
for automotive propulsion  
[UCRL-81178] 21 p0189 N79-11538
- Civilian applications of laser fusion  
[UCRL-52349] 21 p0195 N79-12439
- Comparative properties of fiber composites for  
energy-storage flywheels part A. Evaluation  
of fibers for flywheel rotors  
[UCRL-80116-PT-A] 21 p0215 N79-14165
- Energy and Technology Review, June 1978  
[UCRL-52000-78-6] 21 p0215 N79-14168
- Pulsed power supplied for large laser systems  
[UCRL-80113] 21 p0217 N79-14377
- Comparative cost analyses: Total flow vs other  
power conversion systems for the Salton Sea  
Geothermal Resource  
[UCRL-52589] 22 p0342 N79-17337

## CALIFORNIA UNIV., LOS ANGELES.

- Effect of grain boundaries in silicon on  
minority-carrier diffusion length and  
solar-cell efficiency  
22 p0252 A79-21807
- Technical and environmental aspects of oil shale  
processing  
21 p0199 N79-12581
- Aeroelastic response and stability of a coupled  
rotor/support system with application to large  
horizontal axis with turbines  
22 p0332 N79-16346

## CALIFORNIA UNIV., SANTA BARBARA.

- Oil pollution reports, volume 5, number 2  
[PB-287071/5] 22 p0336 N79-16437

## CALMAC MFG. CO., ENGLEWOOD, N. J.

- Certification report for the CALMAC solar  
powered pump  
[NASA-CR-150872] 22 p0341 N79-17331

## CAMERON ENGINEERS, INC., DENVER, COLO.

- Identification of probable automotive fuels  
consumption: 1985-2000, executive summary  
[HCP/W3684-01/2] 21 p0194 N79-12249
- EPA program status report: Oil shale  
[PB-284480/1] 21 p0211 N79-13548

## CANTERBURY UNIV., CHRISTCHURCH (NEW ZEALAND).

- Energy analysis  
[NP-23145] 21 p0187 N79-11513

## CARRIER CORP., SYRACUSE, N. Y.

- Candidate chemical systems for air cooled, solar  
powered, absorption air conditioner design.  
Part 2: Solid absorbents, high latent heat  
refrigerants  
[SAN/1587-2] 21 p0211 N79-13544

## CATALYTIC, INC., CHARLOTTE, N. C.

- Environmental assessment for residual oil  
utilization  
[PB-286982/4] 22 p0336 N79-16446

## CENTRE NATIONAL D'ETUDES SPATIALES, TOULOUSE

- (FRANCE).  
High accuracy off-shore position finding using  
the GEOLE satellite based system  
22 p0329 N79-15932

## CHICAGO UNIV., ILL.

- Coal anion structure and chemistry of coal  
alkylation  
[COO-4227-2] 21 p0170 N79-10178
- Industrial international data base: Energy  
analysis methodology. Rational use of energy  
program pilot study  
[NATO/CCMS-75] 21 p0206 N79-13508
- Resource analysis: Water and energy as linked  
resources  
[PB-288046/6] 22 p0349 N79-18463

## CITY UNIV. OF NEW YORK.

- Modelling and control of a fluidized bed gasifier  
22 p0332 N79-16345

## CIVIL AND ENVIRONMENTAL ENGINEERING DEVELOPMENT

- OFFICE, TYNDALL AFB, FLA.  
FLAME: Forestry Lands Allocated for Managing  
energy. Feasibility study  
[AD-A059993] 21 p0217 N79-14507

## COAST GUARD, WASHINGTON, D. C.

- Liquefied natural gas safety research overview  
[AD-A063714] 22 p0365 N79-21233

## COLORADO SCHOOL OF MINES, GOLDEN.

- Research on the physical properties of  
geothermal reservoir rock  
[COO-2908-4] 22 p0358 N79-20459

## COLORADO STATE UNIV., FORT COLLINS.

- Liquefied natural gas wind tunnel simulation and  
instrumentation assessments  
[SAN-W1364-01] 21 p0195 N79-12256
- Evaluation of high performance evacuated tubular  
collectors in a residential heating and  
cooling system: Colorado State University  
Solar House 1  
[COO-2577-14] 21 p0206 N79-13507

## Solar evacuated tube collector: Absorption

- chiller systems simulation  
[COO-2577-13] 21 p0209 N79-13530

## COLT, INC. OF SOUTHERN CALIFORNIA, RANCHO MIRAGE.

- Preliminary design package for solar heating and  
hot water system  
[NASA-CR-150619] 21 p0173 N79-10520
- Verification test report on a solar heating and  
hot water system  
[NASA-CR-161165] 22 p0360 N79-20493



## CORPORATE SOURCE INDEX

## DEPARTMENT OF ENERGY, BARTLESVILLE, OKLA.

## COMMITTEE OF THE WHOLE HOUSE OF THE STATE OF THE UNION (U. S. HOUSE).

Authorizing appropriations to the National Aeronautics and Space Administration  
[H-REPT-96-52] 22 p0364 N79-20928

## COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION (U. S. SENATE).

National Aeronautics and Space Act of 1958, as amended, and related legislation  
[GPO-34-175] 21 p0214 N79-13932

Symposium on the Future of Space Science and Space Applications  
[GPO-23-876] 21 p0224 N79-15105

## COMMITTEE ON INTERSTATE AND FOREIGN COMMERCE (U. S. HOUSE).

The national energy plan: Options under assumptions of national security threat  
[H-PRINT-95-48] 21 p0228 N79-15398

The national energy plan: Options under assumptions of national security threat or energy policy as if it really mattered  
[H-PRINT-95-42] 21 p0228 N79-15399

US energy demand and supply, 1976-1985: Limited options, unlimited constraints  
[H-PRINT-95-43] 21 p0228 N79-15400

Energy and the economy: The economic impact of alternative energy supply-demand assumptions  
[H-PRINT-95-51] 22 p0333 N79-16352

Industrial energy conservation  
[GPO-24-067] 22 p0333 N79-16353

## COMMITTEE ON SCIENCE AND TECHNOLOGY (U. S. HOUSE).

United States civilian space programs: An overview  
[GPO-35-823] 21 p0232 N79-15815

Research and development needs to merge environmental and energy objectives  
[GPO-23-254] 22 p0342 N79-17339

Electric and Hybrid Vehicle Act, Public Law 94-413 demonstration program objective and schedule  
[GPO-98-809] 22 p0351 N79-18810

## CONSTOCK AND WESCOTT, INC., CAMBRIDGE, MASS.

NaOH-based high temperature heat-of-fusion thermal energy storage device  
21 p0012 A79-10106

Phase change thermal storage for a solar total energy system  
21 p0120 A79-17321

Development of a phase-change thermal storage system using modified anhydrous sodium hydroxide for solar electric power generation  
[NASA-CR-159465] 22 p0354 N79-19454

## COPPER DEVELOPMENT ASSOCIATION, INC., NEW YORK, N. Y.

Instrumentation at the Decade 80 solar house in Tucson, Arizona  
[NASA-CR-150851] 21 p0204 N79-13491

Final system instrumentation design package for Decade 80 solar house  
[NASA-CR-150869] 22 p0354 N79-19455

## CORNELL UNIV., ITHACA, N. Y.

The anaerobic attached film expanded bed reactor for the treatment of dilute organic wastes  
22 p0356 N79-19928

## COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH, PRETORIA (SOUTH AFRICA).

Symposium on Energy Today and Tomorrow  
[CSIR-S-145] 22 p0340 N79-17316

Coal preparation design for export markets, with particular reference to South African and Canadian coals  
22 p0340 N79-17318

Influence of marketing requirements on definition of coal resources  
22 p0340 N79-17319

Coal gasification and South Africa  
22 p0340 N79-17321

Energy requirements for producing steel in the Republic of South Africa  
22 p0340 N79-17322

Description of hydro-electric development and proposal for future development on the Zambezi  
22 p0340 N79-17323

Low-temperature application of solar energy in South Africa  
22 p0340 N79-17324

The planning and economic aspects of energy supply and demand in South Africa  
22 p0341 N79-17325

## Energy today and tomorrow

22 p0341 N79-17326  
COUNCIL ON ENVIRONMENTAL QUALITY, WASHINGTON, D.C.  
The good news about energy 22 p0355 N79-19461

## CRYSTAL SYSTEMS, INC., SALEM, MASS.

Silicon sheet growth development for the large area sheet task of the low cost solar array project. Heat exchanger method - ingot casting fixed abrasive method - multi-wire slicing  
[NASA-CR-158038] 21 p0219 N79-14540

## CURTISS-WRIGHT CORP., WOOD-RIDGE, N.J.

Rotary engine developments at Curtiss-Wright over the past 20 years and review of general aviation engine potential  
22 p0329 N79-15967

## D

## DAYTON UNIV. RESEARCH INST., OHIO.

A feasibility study of inorganic oxide-fluoride compositions for thermal energy storage applications  
[AD-A059001] 21 p0196 N79-12559

Behavior of nonmetallic materials in shale oil derived jet fuels and in high aromatic and high sulfur petroleum fuels  
[AD-A060322] 21 p0226 N79-15203

## DEFENCE RESEARCH ESTABLISHMENT, OTTAWA, (ONTARIO).

Power supplies for Arctic radio repeater systems  
[AD-A061609] 22 p0339 N79-17118

## DEPARTMENT OF ENERGY, BARTLESVILLE, OKLA.

Performance characteristics of automotive engines in the United States. First Series: Report No. 14 1975 Mazda Rotary 79 CID (1.1 liters), 4V  
[PB-286074/0] 21 p0226 N79-15304

Performance characteristics of automotive engines in the United States. First series: Report no. 15 1975 Dodge Colt 98 CID (1.6 liters), 2V  
[PB-286075/7] 21 p0226 N79-15305

Performance characteristics of automotive engines in the United States. Second series: Report no. 5 1977 Ford 140 CID (2.3 liters), 2V  
[PB-286076/5] 21 p0227 N79-15306

Performance characteristics of automotive engines in the United States Third series: Report No. 1 1977 Volvo 130 CID (2.1 liters), F.I.  
[PB-286077/3] 21 p0227 N79-15307

Performance characteristics of automotive engines in the United States. Second series, report no. 4: 1976 Chevrolet 65 CID (1.4 liters), 4V  
[PB-286294/4] 21 p0227 N79-15308

Performance characteristics of automotive engines in the United States. Second series, report no. 6: 1976 Nissan diesel 198 CID (3.2 liters), F. I.  
[PB-286295/1] 21 p0227 N79-15309

Performance characteristics of automotive engines in the United States. Second series, report no. 7: 1977 Ford 171 CID (2.8 liters), 2V  
[PB-286296/9] 21 p0227 N79-15310

Performance characteristics of automotive engines in the United States. First series, report no. 16: 1975 121 CID (2.0 liters), F.I.  
[PB-286297/7] 21 p0227 N79-15311

Performance characteristics of automotive engines in the United States. First series, report no. 17: 1975 Buick 455 CID (7.5 liters), 4V  
[PB-286298/5] 21 p0227 N79-15312

Performance characteristics of automotive engines in the United States. First series, report no. 18: 1976 Ford CID (6.6 liters), 2V  
[PB-286299/3] 21 p0227 N79-15313

Performance characteristics of automotive engines in the United States. First series, report no. 19: 1975 Ford Windsor 351 CID (5.7 liters), 2V  
[PB-286300/9] 21 p0228 N79-15314

## DEPARTMENT OF ENERGY,

## CORPORATE SOURCE INDEX

Performance characteristics of automotive engines in the United States. First series, report no. 20: 1975 Chevrolet 350 CID (5.7 liters) with Dresser variable-area venturi system  
[PB-286301/7] 21 p0228 N79-15315

DEPARTMENT OF ENERGY, MORGANTOWN, W. VA.  
Fluidized-bed combustion test of low-quality fuels: Texas lignite and lignite refuse  
[MEHC/R1-78/3] 21 p0175 N79-10543

DEPARTMENT OF ENERGY, OAK RIDGE, TENN.  
Energy information data base. Guide to abstracting and indexing  
[TID-4583-R1] 21 p0184 N79-11488

Electric batteries. A bibliography  
[TID-3361] 21 p0184 N79-11491

Energy information data base: Serial titles  
[TID-4579-R10] 21 p0197 N79-12566

DEPARTMENT OF ENERGY, PITTSBURGH, PA.  
An approach to automated longwall mining  
[ATAA PAPER 79-0532] 22 p0274 A79-25871

DEPARTMENT OF ENERGY, WASHINGTON, D. C.  
SIMWEST - A simulation model for wind energy storage systems  
21 p0029 A79-10241

Energy and remote sensing applications  
22 p0255 A79-22516

Hydrogen energy storage program: Five-year plan  
[DOE/ET-0046] 21 p0175 N79-10544

Environmental development Plan (EDP). Oil supply, FY 1977  
[DOE/EDP-C024] 21 p0175 N79-10545

Battery and electrochemical systems program summary, FY 1977  
[DOE/ET-0014] 21 p0176 N79-10546

Improved Conversion Efficiency Workshop. Volume 2: Summary  
[CONP-771003-P2-VOL-2] 21 p0176 N79-10551

Comprehensive overview of winter energy data bulletins  
[PB-282787/1] 21 p0177 N79-10565

Environmental control technology activities of the Department of Energy in FY 1977  
[DOE/EV-0030] 21 p0178 N79-10572

Alcohol fuels program plan  
[DOE/US-0001/2] 21 p0180 N79-11242

Solar heating and cooling demonstration project summaries  
[DOE/CS-0009] 21 p0186 N79-11503

Environmental Development Plan (EDP): Solar thermal power systems, 1977  
[DOE/EDP-0004] 21 p0187 N79-11522

Environmental Development Plan (EDP): Ocean thermal energy conversion, 1977  
[DOE/EDP-006] 21 p0188 N79-11531

Federal Energy Data System (FEOS) technical documentation  
[PB-281815/1] 21 p0189 N79-11542

Environmental Development Plan (EDP): Underground coal conversion program, FY 1977  
[DOE/EDP-0011] 21 p0192 N79-11569

Overview of the magnetic fusion energy development and technology program  
[HCP/T3073-01] 21 p0193 N79-11887

National photovoltaic program plan  
[DOE/ET-0035(78)] 21 p0197 N79-12567

Environmental Development Plan (EDP): Photovoltaics, 1977  
[DOE/EDP-0003] 21 p0198 N79-12569

Silicon Schottky photovoltaic diodes for solar energy conversion  
[PB-283998/3] 21 p0198 N79-12572

Comparative automotive engine operation when fueled with ethanol and methanol  
[HCP/W1737-01] 21 p0201 N79-13189

Program information notice  
[DOE/ET-0059] 21 p0207 N79-13517

Solar thermal power systems program: Program summary  
[DOE/ET-0018/1] 21 p0207 N79-13518

Solar heating and cooling. Research and development: Project summaries  
[DOE/CS-0010] 21 p0208 N79-13519

Photovoltaic program: Program summary  
[DOE/ET-0019/1] 21 p0209 N79-13529

Solar energy  
[DOE/ET-0062] 21 p0210 N79-13535

Requirements for environmental monitoring assessment, and controls for nonnuclear energy demonstration projects. Report to Congress, prepared in fulfillment of Public Law 95-39, section 113  
[DOE/EV-0014] 21 p0213 N79-13573

Coal loan guarantee program (PL 94-163)  
[DOE/EIS-0004] 21 p0213 N79-13574

Proposed standby gasoline rationing plan. Economic and regulatory analysis draft  
[DOE/ERA-0009] 21 p0214 N79-13934

Phase one/base data for the development of energy performance standards for new buildings: Sample design  
[PB-286903/0] 22 p0331 N79-16150

Satellite Power System (SPS) program summary  
[DOE/ER-0022] 22 p0337 N79-16893

Fluidized-bed combustion  
22 p0347 N79-18365

Characterization study of an electric motor-transmission system for electric vehicles  
[HCP/M2835-01] 22 p0351 N79-18817

Measuring energy conservation  
[DOE/EIA-0103/18] 22 p0362 N79-20509

Environmental impact determination of action to be taken under the Energy Supply and Environmental Coordination Act for powerplants 1, 2, 3, and 4, Portsmouth Generating Station, Portsmouth, Virginia  
[DOE/EA-0033] 22 p0362 N79-20514

Satellite power system: Concept development and evaluation program, reference system report  
[NASA-TM-80413] 22 p0367 N79-21538

DEPARTMENT OF THE AIR FORCE, WASHINGTON, D. C.  
Evolution of space power systems  
[IAF PAPER 78-43] 21 p0035 A79-11218

DEPARTMENT OF TRANSPORTATION, WASHINGTON, D. C.  
Energy in transportation  
[PB-282928/1] 21 p0177 N79-10561

DOW CHEMICAL CO., MIDLAND, MICH.  
Chemicals from coal. Report based on HRI H-coal product  
[FE-1534-50] 21 p0180 N79-11166

DUBIN-BLOOME ASSOCIATES, NEW YORK.  
Solar assisted heat pump study for heating of military facilities  
[AD-A058626] 21 p0206 N79-13506

DYNAMICS RESEARCH CORP., WILMINGTON, MASS.  
An analysis of fuel conserving operational procedures and design modifications for bomber/transport aircraft. Volume 1: Executive summary  
[AD-A061746] 22 p0351 N79-18969

An analysis of fuel conserving operational procedures and design modifications for bomber/transport aircraft, volume 2  
[AD-A062609] 22 p0356 N79-20109

## E

EAGLE-PICHER CO., JOPLIN, MO.  
Nickel-zinc battery for aircraft and missile applications  
[AD-A059295] 21 p0220 N79-14561

EAGLE-PICHER INDUSTRIES, INC., JOPLIN, MO.  
Multistack nickel-hydrogen units  
22 p0371 N79-21610

EASTERN OREGON COMMUNITY DEVELOPMENT COUNCIL, LA GRANDE.  
Energy education training: Feasibility study.  
[PB-285910/6] 21 p0230 N79-15428

ECON, INC., PRINCETON, N. J.  
Costing the satellite power system  
[AAS PAPER 78-166] 22 p0243 A79-21270

Economics of fusion research  
[COO-4181-] 21 p0193 N79-11890

Statement of Doctor Klaus Heiss, President, ECON, Incorporated, Princeton, New Jersey  
21 p0224 N79-15110

Assessment of economic factors affecting the satellite power system. Volume 1: System cost factors  
[NASA-CR-161185] 22 p0368 N79-21551

Assessment of economic factors affecting the satellite power system. Volume 2: The systems implications of rectenna siting issues  
[NASA-CR-161186] 22 p0368 N79-21552

- ECOVIEV, NAPA, CALIF.**  
Direct heat applications of geothermal energy in the geysers/Clear Lake Region, volume 2: Environmental assessment  
[SAN/1326-1/2] 21 p0174 N79-10532  
Energy conservation and the rural home: Economic considerations for the nation and the individual  
[PB-286222/5] 21 p0230 N79-15425
- EDGERTON, GERMESHAUSEN AND GRIER, INC., ALBUQUERQUE, N.MEX.**  
Performance testing of the Hexcel Parabolic Trough Solar Collector  
[SAND-76-0381] 21 p0221 N79-14569
- EDGERTON, GERMESHAUSEN AND GRIER, INC., IDAHO FALLS, IDAHO.**  
Measurement and control techniques in geothermal power plants  
[TREE-1312] 22 p0362 N79-20508
- ELCAM, INC., SANTA BARBARA, CALIF.**  
Prototype solar-heated hot water systems and double-walled heat exchangers  
[NASA-CR-150854] 21 p0205 N79-13495
- ELECTRIC STORAGE BATTERY CO., YARDLEY, PA.**  
Sodium-antimony trichloride battery development program for load leveling  
[EPRI-EM-751] 21 p0186 N79-11501
- ENERGY AND ENVIRONMENTAL ANALYSIS, INC., ARLINGTON, VA.**  
End use energy consumption data base: Series 1 tables  
[PB-281817/7] 21 p0177 N79-10560
- ENERGY AND ENVIRONMENTAL RESEARCH CORP., SANTA ANA, CALIF.**  
Low NOx combustion concepts for advanced power generation systems firing low-Btu gas  
[PB-282983/6] 21 p0178 N79-10610
- ENERGY, INC., IDAHO FALLS, IDAHO.**  
Energy supply and environmental impacts: Conventional sources, study module 3-A, technical appendix  
[PB-283787/0] 21 p0198 N79-12573
- ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION, GRAND FORKS, N. DAK.**  
Technology and Use of Lignite  
[GPERC/IC-77/1] 21 p0216 N79-14241
- ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION, WASHINGTON, D. C.**  
Need for and deployment of inexhaustible energy resource technologies: Report of Technology Study Panel inexhaustible energy resources study  
[TID-28202] 21 p0186 N79-11510
- Silicon Schottky photovoltaic diodes for solar energy conversion**  
[PB-287417/0] 22 p0343 N79-17349
- ENERGY RESEARCH CORP., BETHEL, CONN.**  
Fabrication and testing of silver-hydrogen cells  
[NASA-CR-159431] 22 p0334 N79-16374
- ENVIRONMENTAL LAW INST., WASHINGTON, D. C.**  
Legal barriers to solar heating and cooling of buildings  
[HCP/M2528-1] 21 p0209 N79-13534
- ENVIRONMENTAL MONITORING AND SUPPORT LAB., CINCINNATI, OHIO.**  
Analysis of radioactive contaminants in by-products from coal-fired power plant operations  
[PB-286365/2] 21 p0232 N79-15473
- ENVIRONMENTAL PROTECTION AGENCY, ANN ARBOR, MICH.**  
Investigation of turbo-dyne energy chamber (G:R: value trademark): An air bleed device  
[PB-285381/0] 21 p0217 N79-14397
- Effects of low ambient temperature on the exhaust emissions and fuel economy of 84 automobiles in Chicago**  
[PB-288400/5] 22 p0355 N79-19488
- ENVIRONMENTAL PROTECTION AGENCY, CINCINNATI, OHIO.**  
Methods for the control of environmental damage caused by mining energy producing materials  
22 p0347 N79-18359
- ENVIRONMENTAL PROTECTION AGENCY, DULUTH, MINN.**  
Ecological effects of coal-fired steam-electric generating stations  
22 p0346 N79-18358
- ENVIRONMENTAL PROTECTION AGENCY, RESEARCH TRIANGLE PARK, N.C.**  
National Emissions Data System (NEDS) fuel use report (1974)  
[PB-284658/2] 21 p0194 N79-12251
- Status of bioscreening of emissions and effluents from energy technologies**  
22 p0346 N79-18353
- Interagency coal cleaning technology development**  
22 p0347 N79-18361
- National Emissions Data Systems (NEDS) fuel use report (1975)**  
[PB-290162/7] 22 p0373 N79-21670
- ENVIRONMENTAL PROTECTION AGENCY, WASHINGTON, D. C.**  
Energy environment III  
[EPA-600/9-78-022] 22 p0346 N79-18352
- Public hearing transcript: Federal non-nuclear energy research and development program**  
[PB-287910/4] 22 p0349 N79-18464
- ENVIRONMENTAL SYSTEMS, INC., ANNAPOLIS, MD.**  
Use of solar energy to heat anaerobic digesters. Part 1: Technical and economic feasibility study. Part 2: Economic feasibility throughout the United States  
[PB-286940/2] 21 p0231 N79-15440
- F**
- FAUCETT (JACK) ASSOCIATES, INC., CHEVY CHASE, MD.**  
End use energy consumption data base: Series 1 tables  
[PB-281817/7] 21 p0177 N79-10560
- FEDERAL-STATE LAND USE PLANNING COMMISSION FOR ALASKA, ANCHORAGE.**  
Northern Alaska hydrocarbon resources  
[PB-287394/1] 22 p0332 N79-16342
- FEDERAL ENERGY ADMINISTRATION, WASHINGTON, D. C.**  
Energy information: Report to Congress  
[NTISUB/C/027-001] 21 p0221 N79-14576
- FISH AND WILDLIFE SERVICE, FORT COLLINS, COLO.**  
Texas lignite: Environmental planning opportunities  
[PB-286870/1] 21 p0231 N79-15438
- Reservoir ecosystems and western coal development in the upper Missouri River Basin**  
[PB-287363/6] 22 p0339 N79-17309
- FLORIDA AGRICULTURAL AND MECHANICAL UNIV., TALLAHASSEE.**  
Energy: The new economic development wildcard  
[PB-282494/4] 21 p0177 N79-10564
- FLORIDA UNIV., GAINESVILLE.**  
Application of the superposition principle to solar-cell analysis  
22 p0300 N79-29426
- MHD generator duct flow with cross stream dependent fluid properties**  
22 p0336 N79-16668
- FLUOR ENGINEERS AND CONSTRUCTORS, INC., IRVINE, CALIF.**  
Economics of fuel gas from coal: An update including the British Gas Corporation's slagging gasifier  
[EPRI-AP-782] 21 p0180 N79-11238
- Economics of Texaco gasification: Combined cycle systems. Economic studies of coal gasification combined cycle systems for electric power generation**  
[EPRI-AP-753] 21 p0185 N79-11498
- FORD MOTOR CO., DEARBORN, MICH.**  
Automotive Stirling engine development program  
[NASA-CR-159436] 21 p0181 N79-11406
- Evaluation of ceramics for stator application: Gas turbine engine report**  
[NASA-CR-159533] 22 p0364 N79-21075
- FOREST PRODUCTS LAB., MADISON, WIS.**  
Methanol from wood waste: A technical and economic study  
[FPL-12] 21 p0194 N79-12239
- FRANKLIN INST. RESEARCH LABS., ROCKVILLE, MD.**  
A literature review-problem definition studies on selected toxic chemicals. Volume 1: Occupational health and safety aspects of diesel fuel and white smoke generated from it  
[AD-A056018] 21 p0192 N79-11686
- A literature review-problem definition studies on selected toxic chemicals. Volume 8: Environmental aspects of diesel fuel and fog oils SGF number 1 and SGF number 2 and smoke screens generated from them**  
[AD-A056021] 21 p0193 N79-11688

## G

GARRETT ENERGY RESEARCH AND ENGINEERING, INC.,  
CLAREMONT, CALIF.

- Conversion of biomass materials into gaseous products, phase 1  
[SAN/1241-77/1] 21 p0171 N79-10237
- GENERAL ACCOUNTING OFFICE, WASHINGTON, D. C.  
The Federal Government should establish and meet energy conservation goals  
[PB-283066/9] 21 p0190 N79-11546
- Region at the crossroads: The Pacific Northwest searches for new sources of electric energy  
[PB-284691/3] 21 p0222 N79-14583
- GAO work involving title V of the Energy Policy and Conservation Act of 1975  
[PB-286400/7] 21 p0230 N79-15424
- Evaluation of four energy conservation programs--fiscal year 1977  
[PB-288825/3] 22 p0355 N79-19472
- GENERAL ATOMIC CO., SAN DIEGO, CALIF.  
Fixed mirror solar concentrator for power generation  
[GA-A-14883] 21 p0187 N79-11526
- Parametric requirements for noncircular Tokamak commercial fusion plants  
[GA-A-14876] 21 p0214 N79-13871
- Parametric requirements for noncircular Tokamak commercial fusion plants  
[GA-A-14946] 21 p0214 N79-13872
- Large closed-cycle gas turbine plant  
[GA-A-14311] 22 p0331 N79-16261
- GENERAL DYNAMICS/CONVAIR, SAN DIEGO, CALIF.  
Achievable flatness in a large microwave power antenna study  
[NASA-CR-151831] 21 p0171 N79-10272
- Vehicle Design Evaluation Program (VDEP). A computer program for weight sizing, economic, performance and mission analysis of fuel-conservative aircraft, multibodied aircraft and large cargo aircraft using both JP and alternative fuels  
[NASA-CR-145070] 21 p0200 N79-13026
- GENERAL ELECTRIC CO., PHILADELPHIA, PA.  
Ultralow-mass solar-array designs for Halley's comet rendezvous mission  
21 p0020 A79-10169
- The application of photovoltaic roof shingles to residential and commercial buildings  
21 p0020 A79-10170
- Background and system description of the Mod 1 wind turbine generator  
22 p0239 A79-20825
- Wind turbine generator application places unique demands on tower design and materials  
22 p0240 A79-20826
- Fatigue impact on Mod-1 wind turbine design  
22 p0240 A79-20827
- The application of hydraulics in the 2,000 kW wind turbine generator  
22 p0288 A79-27400
- Solar heating and cooling system design and development  
[NASA-CR-150803] 21 p0172 N79-10516
- Applied research on energy storage and conversion for photovoltaic and wind energy systems. Volume 3: Wind conversion systems with energy storage  
[HCP/T22221-01/3] 21 p0189 N79-11535
- Mini-Brayton heat source assembly development  
[NASA-CR-159447] 21 p0196 N79-12554
- Applied research on energy storage and conversion for photovoltaic and wind energy systems. Volume 2: Photovoltaic systems with energy storage  
[HCP/T22221-01/2-2] 21 p0207 N79-13510
- Applied research on energy storage and conversion for photovoltaic and wind energy systems. Volume 1: Study summary and concept screening  
[HCP/T22221-01/1-VOL-1] 21 p0207 N79-13511
- Coal desulfurization using microwave energy  
[PB-285880/1] 21 p0216 N79-14243
- Conceptual approach study 200 watt per kilogram solar array, phase 3  
[NASA-CR-158046] 21 p0219 N79-14551
- MHD-ETP program. Volume 1: Executive summary  
[PE-2613-6-VOL-1] 22 p0362 N79-20515

- MHD-ETP program. Volume 2A, parts 1 and 2: Reference design description  
[PE-2613-6-VOL-2A] 22 p0363 N79-20516
- GENERAL ELECTRIC CO., SANTA BARBARA, CALIF.  
Conceptual design of thermal energy storage systems for near term electric utility applications. Volume 1: Screening of concepts  
[NASA-CR-159411-VOL-1] 21 p0205 N79-13496
- GENERAL ELECTRIC CO., SCHENECTADY, N. Y.  
A study of flywheel energy storage for urban transit vehicles  
[PB-282929/9] 21 p0177 N79-10563
- Development of sodium-sulfur batteries for utility application  
[EPRI-EM-683] 21 p0186 N79-11502
- GENERAL ELECTRIC CO., WILMINGTON, MASS.  
Evaluation and optimization of Solid Polymer Electrolyte (SPE) fuel cells  
[AD-A058380] 21 p0206 N79-13505
- Solid Polymer Electrolyte (SPE) fuel cell technology program  
[NASA-CR-160159] 22 p0371 N79-21622
- GEOENERGY CORP., LAS VEGAS, NEV.  
An assessment of subsurface salt water disposal experience on the Texas and Louisiana Gulf coast for application to disposal of salt water from geopressured geothermal wells  
[NVO/1531-2] 22 p0366 N79-21523
- GEOLOGICAL SURVEY, DENVER, COLO.  
Late diagenetic indicators of buried oil and gas. 2: Direct detection experiment at Cement and Garza fields, Oklahoma and Texas, using enhanced LANDSAT 1 and 2 images  
[E79-10099] 22 p0347 N79-18373
- GEORGIA INST. OF TECH., ATLANTA.  
Thermal analysis of receivers for solar concentrators and optimization procedure for power production  
21 p0182 N79-11465
- GEORGIA UNIV., ATHENS.  
Comparison of the solar concentrating properties of truncated hexagonal, pyramidal and circular cones  
21 p0043 A79-11974
- GHOSTIC CONCEPTS, INC., MENLO PARK, CALIF.  
Industrialization study  
[NASA-CR-157953] 21 p0200 N79-12970
- Industrialization study, phase 2  
[NASA-CR-158015] 22 p0333 N79-16351
- GORDIAN ASSOCIATES, INC., NEW YORK.  
Heat pump technology: A survey of technical developments, market prospects and research needs  
[HCP/M2121-01] 21 p0210 N79-13540
- GRUMMAN AEROSPACE CORP., BETHPAGE, N.Y.  
Space solar power - An energy alternative  
22 p0303 A79-29796
- Manned remote work station development article  
[NASA-CR-151871] 22 p0330 N79-16057
- The 25 kW space station  
22 p0371 N79-21608
- GULF UNIVERSITIES RESEARCH CONSORTIUM, BELLAIRE, TEX.  
Potential producibility and recovery of natural gas from geopressured aquifers of the Cenozoic sediments of the Gulf Coast Basin  
[PE-2025-3] 21 p0192 N79-11607

## H

- HAMILTON STANDARD DIV., UNITED AIRCRAFT CORP., WINDSOR LOCKS, CONN.  
Wind-turbine-generator rotor-blade concepts with low-cost potential  
22 p0240 A79-20828
- HAWAII UNIV., HONOLULU.  
Control of wind turbine generators connected to power systems  
21 p0086 A79-15574
- Oahu wind power survey  
[PB-287361/0] 22 p0335 N79-16382
- HITTHAN ASSOCIATES, INC., COLUMBIA, MD.  
Standards of Practice Manual for the solvent refined coal liquefaction process  
[PB-283028/9] 21 p0178 N79-10595
- Environmental assessment data base for coal liquefaction technology. Volume 1: Systems for 14 liquefaction processes  
[PB-287799/1] 22 p0344 N79-17364

- Environmental assessment data base for coal liquefaction technology. Volume 2: Synthoil, H-coal, and Exxon donor solvent processes [PB-287800/7] 22 p0344 N79-17365
- Air quality impacts using SRC versus conventional coal in power plants [PB-290237/7] 22 p0373 N79-21671
- HONEYWELL, INC., MINNEAPOLIS, MINN.**
- Solar pilot plant, phase 1 [SAN/1109-77-7] 21 p0210 N79-13542
- Preliminary design package for prototype solar heating system [NASA-CR-150858] 21 p0220 N79-14557
- Preliminary design package for prototype solar heating and cooling systems [NASA-CR-150853] 21 p0229 N79-15409
- Preliminary design package for residential heating/cooling system: Rankine air conditioner redesign [NASA-CR-150871] 22 p0354 N79-19453
- Active heat exchange system development for latent heat thermal energy storage [NASA-CR-759479] 22 p0368 N79-21554
- HOUSTON UNIV., TEX.**
- Environmental effects of offshore oil production 22 p0336 N79-16389
- HUGHES RESEARCH LABS., MALIBU, CALIF.**
- GaAs solar cell development [NASA-CR-158090] 22 p0334 N79-16366
- HYDROCARBON RESEARCH, INC., LAWRENCEVILLE, N. J.**
- Demetallization catalyst tests on heavy residual oils [PB-285937/9] 21 p0232 N79-15864
- Catalyst evaluation for denitrogenation of petroleum residua and coal liquids, phase 5 [PB-287180/4] 22 p0339 N79-17026
- IBM FEDERAL SYSTEMS DIV., HUNTSVILLE, ALA.**
- SIMS prototype system 4 - performance test report [NASA-CR-150820] 21 p0205 N79-13499
- System design package for SIMS prototype system 3: solar heating and domestic hot water [NASA-CR-150840] 22 p0333 N79-16359
- System design package for SIMS prototype system 4: solar heating and domestic hot water [NASA-CR-150839] 22 p0333 N79-16361
- System integration of marketable subsystems [NASA-CR-161104] 22 p0348 N79-18448
- ILLINOIS ENERGY RESOURCES COMMISSION, SPRINGFIELD.**
- Solid waste and biomass. Their potential as energy sources in Illinois, 1977 [PB-281649/4] 21 p0177 N79-10562
- ILLINOIS UNIV. AT URBANA-CHAMPAIGN, URBANA.**
- Energy and environment: An intergovernmental perspective [PB-283733/4] 21 p0198 N79-12575
- ILLINOIS UNIV., URBANA-CHAMPAIGN.**
- Resource analysis: Water and energy as linked resources [PB-288046/6] 22 p0349 N79-18463
- ILLINOIS VALLEY ECONOMIC DEVELOPMENT CORP., CARLINVILLE.**
- Solar space heaters for low-income families [PB-289244/6] 22 p0363 N79-20526
- IMPERIAL COLL. OF SCIENCE AND TECHNOLOGY, LONDON (ENGLAND).**
- Future fuels for aviation 21 p0201 N79-13193
- The role of fundamental combustion in the future aviation fuels program 21 p0202 N79-13195
- INDUSTRIAL ENVIRONMENTAL RESEARCH LAB., CINCINNATI, OHIO.**
- Pollution control guidance for geothermal energy development [PB-282546/1] 21 p0178 N79-10604
- INDUSTRIAL ENVIRONMENTAL RESEARCH LAB., RESEARCH TRIANGLE PARK, N. C.**
- Demetallization catalyst tests on heavy residual oils [PB-285937/9] 21 p0232 N79-15864
- EPA program conference report: Coal cleaning, an option for Increased Coal Utilization [PB-288223/1] 22 p0344 N79-17378
- INSTITUTE FOR ENERGY ANALYSIS, OAK RIDGE, TENN.**
- Three modes of energy cost analysis: Then-current dollars, base-year dollars, and perpetual-constant dollars [ORAU/IEA(M)-78-10] 21 p0209 N79-13531
- INSTITUTE OF GAS TECHNOLOGY, CHICAGO, ILL.**
- Feasibility study of transporting offshore OTEC-produced energy to shore by thermal media. Project 8980 [DSE/2426-19] 21 p0174 N79-10535
- JET PROPULSION LAB., CALIF. INST. OF TECH., PASADENA.**
- User experience with on-road electric vehicles in the U.S.A. and Canada 21 p0009 A79-10080
- A technical analysis for cogeneration systems with potential applications in twelve California industrial plants 21 p0011 A79-10099
- High temperature thermal energy storage in moving sand 21 p0012 A79-10103
- JPL - Small Power Systems Applications Project 21 p0019 A79-10161
- Performance and economic risk evaluation of dispersed solar thermal power systems by Monte Carlo simulation 21 p0020 A79-10163
- Effects of pointing errors on receiver performance for parabolic dish solar concentrators 21 p0020 A79-10167
- Ultralow-mass solar-array designs for Halley's comet rendezvous mission 21 p0020 A79-10169
- The application of photovoltaic roof shingles to residential and commercial buildings 21 p0020 A79-10170
- Comparative evaluation of distributed-collector solar thermal electric power plants 21 p0021 A79-10173
- Cooling radioisotope thermoelectric generators in the Shuttle 21 p0023 A79-10186
- The application of solar thermoelectric generators in near-sun missions 21 p0023 A79-10187
- Design of a preprototype Stirling Laboratory Research Engine 21 p0024 A79-10203
- Prospects of thermionic power systems 21 p0026 A79-10220
- Selenide technology evaluation program at JPL 21 p0026 A79-10222
- Analytical predictions of selenide RTG power degradation 21 p0026 A79-10223
- Modified silicon-germanium alloys with improved performance 21 p0027 A79-10225
- Optimum antireflection coating for Antireflection-coated Metal-Oxide-Semiconductor /AMOS/ solar cells 21 p0042 A79-11955
- Coal desulfurization by low-temperature chlorinolysis 21 p0045 A79-12119
- Feasibility of rocket propellant production on Mars 21 p0047 A79-12324
- Solar thermal power systems point-focusing distributed receiver /PPDR/ technology - A project description [IAEA PAPER 78-1771] 21 p0062 A79-13869
- Electricity from sunlight 21 p0065 A79-14116
- Total solar irradiance at Table Mtn, California 1926-77 21 p0067 A79-14269
- Calibration standards and field instruments for the precision measurement of insolation 21 p0076 A79-14765
- A probabilistic model of insolation for the Mojave desert-area 21 p0076 A79-14766
- Advanced composites - Future space applications 21 p0086 A79-15504

- Hail risk model for solar collectors  
21 p0098 A79-16103
- Simulated hail impact testing of photovoltaic solar panels  
21 p0098 A79-16116
- A graphical approach to the efficiency of flat-plate collectors  
21 p0102 A79-16422
- Solar collectors. I - Fundamentals and collectors of the past and present  
21 p0103 A79-16455
- Solar thermal conversion  
21 p0104 A79-16466
- SPS microwave subsystem potential impacts and benefits  
21 p0107 A79-16603
- Large active retrodirective arrays for solar power satellites  
21 p0107 A79-16604
- Energy conversion at a lunar polar site  
21 p0108 A79-16607
- Overview of novel photovoltaic conversion techniques at high intensity levels  
21 p0108 A79-16610
- Efficiency degradation due to tracking errors for point focusing solar collectors  
[ASME PAPER 78-WA/SOL-4] 21 p0162 A79-19837
- Solar receiver performance of point focusing collector system  
[ASME PAPER 78-WA/SOL-5] 21 p0163 A79-19838
- Accelerating the commercialization on new technologies  
[ASME PAPER 78-WA/TS-4] 21 p0164 A79-19849
- Integral assembly of photovoltaic arrays using glass  
22 p0241 A79-20883
- Hydrogen enrichment for low-emission jet combustion  
22 p0244 A79-21347
- Effect of grain boundaries in silicon on minority-carrier diffusion length and solar-cell efficiency  
22 p0252 A79-21807
- Design concepts of solar thermoelectric generators in space applications  
22 p0260 A79-23612
- Encapsulant materials for \$2/watt terrestrial photovoltaic arrays  
22 p0266 A79-24138
- Continuous extrusion of coal  
22 p0282 A79-26372
- Structural cost optimization of photovoltaic central power station modules and support structure  
[ASME PAPER 79-SOL-17] 22 p0309 A79-30551
- Photovoltaics and solar thermal conversion to electricity - Status and prospects  
22 p0326 A79-31924
- Dual membrane hollow fiber fuel cell and method of operating same  
[NASA-CASE-NPO-13732-1] 21 p0172 N79-10513
- Surfactant-assisted liquefaction of particulate carbonaceous substances  
[NASA-CASE-NPO-13904-1] 21 p0179 N79-11152
- Non-tracking solar energy collector system  
[NASA-CASE-NPO-13817-1] 21 p0182 N79-11471
- Characterization of solar cells for space applications. Volume 4: Electrical characteristics of Spectrolab BSF 200-micron Helios cells as a function of intensity and temperature  
[NASA-CR-157934] 21 p0195 N79-12543
- Satellite Power System (SPS) environmental impacts, preliminary assessment  
[NASA-CR-157952] 21 p0196 N79-12557
- Satellite Power System (SPS) microwave subsystem impacts and benefits  
[NASA-CR-157951] 21 p0196 N79-12558
- Microwave power transmitting phased array antenna research project  
[NASA-CR-157843] 21 p0202 N79-13263
- The Otto-engine-equivalent vehicle concept  
[NASA-CR-157840] 21 p0203 N79-13370
- A synoptic description of coal basins via image processing  
[NASA-CR-157970] 21 p0204 N79-13474
- Parametric study of two planar high power flexible solar array concepts  
[NASA-CR-157841] 21 p0205 N79-13501
- Utilization of waste heat in trucks for increased fuel economy  
[NASA-TM-79966] 21 p0215 N79-13937
- Primary reflector for solar energy collection systems  
[NASA-CASE-NPO-13579-4] 21 p0217 N79-14529
- Novel duplex vapor electrochemical method for silicon solar cells  
[NASA-CR-158039] 21 p0218 N79-14537
- Concentrator enhanced solar arrays design study  
[NASA-CR-158032] 21 p0219 N79-14546
- Development of a model and computer code to describe solar grade silicon production processes  
[NASA-CR-158037] 21 p0219 N79-14555
- Analysis and evaluation of process and equipment in tasks 2 and 4 of the Low Cost Solar Array project  
[NASA-CR-158089] 22 p0335 N79-16378
- Thermal energy transformer  
[NASA-CASE-NPO-14058-1] 22 p0348 N79-18443
- Block 4 solar cell module design and test specification for residential applications  
[NASA-CR-158117] 22 p0348 N79-18453
- The updated algorithm of the Energy Consumption Program (ECP): A computer model simulating heating and cooling energy loads in buildings  
22 p0351 N79-19059
- A two-dimensional thermal analysis of a new high-performance tubular solar collector  
22 p0352 N79-19060
- Primary lithium battery technology and its application to NASA missions  
[NASA-CR-158229] 22 p0354 N79-19449
- Bioconversion study conducted by JPL  
[NASA-CR-158228] 22 p0354 N79-19450
- Thermal and other tests of photovoltaic modules performed in natural sunlight  
[NASA-CR-158174] 22 p0354 N79-19460
- LSA Low-cost Solar Array project  
[NASA-CR-158250] 22 p0355 N79-19462
- Borehole geological assessment  
[NASA-CASE-NPO-14231-1] 22 p0356 N79-19521
- Development of economical improved thick film solar cell contact  
[NASA-CR-158358] 22 p0359 N79-20486
- A fixed tilt solar collector employing reversible vee-through reflectors and evaluated tube receivers for solar heating and cooling systems  
[NASA-CR-158420] 22 p0359 N79-20490
- The parabolic concentrating collector: A tutorial  
[NASA-CR-158246] 22 p0359 N79-20491
- Thermal power systems point-focusing distributed receiver technology project. Volume 1: Executive summary  
[NASA-CR-158421] 22 p0360 N79-20492
- An improved solar energy receiver for a stirling engine  
[NASA-CASE-NPO-14619-1] 22 p0362 N79-20513
- A low cost high temperature sun tracking solar energy collector  
22 p0366 N79-21390
- Feasibility study of solar dome encapsulation of photovoltaic arrays  
[NASA-CR-158368] 22 p0367 N79-21545
- Power coupling alternatives for the NEP thermionic power system  
[NASA-CR-158372] 22 p0367 N79-21547
- Thermal power systems small power systems applications project. Decision analysis for evaluating and ranking small solar thermal power system technologies. Volume 1: A brief introduction to multiattribute decision analysis  
[NASA-CR-158425] 22 p0368 N79-21548
- Effort of the Jet Propulsion Laboratory  
22 p0370 N79-21575
- JOHNS HOPKINS UNIV., BALTIMORE, MD.  
Solar heating of buildings: Design optimization and economic analysis  
22 p0353 N79-19439
- JOHNS HOPKINS UNIV., LAUREL, MD.  
Energy programs at The Johns Hopkins University Applied Physics Laboratory  
[PB-283171/7] 21 p0191 N79-11554
- Energy programs at The Johns Hopkins University Applied Physics Laboratory  
[PB-283170/9] 21 p0191 N79-11555

## K

- KANAN AEROSPACE CORP., BLOOMFIELD, CONN.**  
Wind-turbine-generator rotor-blade concepts with low-cost potential 22 p0240 A79-20828
- KAYEX CORP., ROCHESTER, N. Y.**  
Continuous Czochralski growth: Silicon sheet growth development of the large area silicon sheet task of the Low Cost Silicon Solar Array project [NASA-CR-158096] 22 p0334 N79-16369
- KENTUCKY UNIV., LEXINGTON.**  
A Kentucky energy resource utilization program [PB-283796/1] 21 p0198 N79-12574  
Proceedings of Energy Resource 5th Conference [PB-286246/4] 21 p0230 N79-15423
- KERR (ROBERT S.) ENVIRONMENTAL RESEARCH LAB., ADA, OKLA.**  
Treatment of petroleum refinery, petrochemical and combined industrial-municipal wastewaters with activated carbon: Literature review [PB-288211/6] 22 p0350 N79-18497
- KVB ENGINEERING, INC., TUSTIN, CALIF.**  
Low-sulfur western coal use in existing small and intermediate size boilers [PB-287937/7] 22 p0346 N79-18061

## L

- LANAR UNIV., BEAUMONT, TEX.**  
Electricity from sunlight 21 p0065 A79-14116  
Process feasibility study in support of silicon material task 1 [NASA-CR-158034] 21 p0219 N79-14541
- LEVELTON (B. H.) AND ASSOCIATES LTD., VANCOUVER (BRITISH COLUMBIA).**  
An evaluation of wood-waste energy conversion systems 21 p0174 N79-10528
- LIBRARY OF CONGRESS, WASHINGTON, D. C.**  
The national energy plan: Options under assumptions of national security threat [H-PRINT-95-48] 21 p0228 N79-15398  
The national energy plan: Options under assumptions of national security threat or energy policy as if it really mattered [H-PRINT-95-42] 21 p0228 N79-15399  
US energy demand and supply, 1976-1985: Limited options, unlimited constraints [H-PRINT-95-43] 21 p0228 N79-15400  
United States civilian space programs: An overview [GPO-35-823] 21 p0232 N79-15815  
Energy and the economy: The economic impact of alternative energy supply-demand assumptions [H-PRINT-95-51] 22 p0333 N79-16352  
Research and development needs to merge environmental and energy objectives [GPO-23-254] 22 p0342 N79-17339
- LINCOLN COLL., CANTERBURY (NEW ZEALAND).**  
Energy analysis [NP-23145] 21 p0187 N79-11513
- LINCOLN LAB., MASS. INST. OF TECH., LEXINGTON.**  
Flywheel components for satellite applications [AD-A060586] 21 p0226 N79-15145
- LINCON CORP., PASADENA, CALIF.**  
Automatic phase control in solar power satellite systems [NASA-CR-151856] 21 p0194 N79-12130
- LITTLE (ARTHUR D.), INC., CAMBRIDGE, MASS.**  
Recommended performance standards for electric and hybrid vehicles [SAW/1335-1] 21 p0195 N79-12450  
Energy use patterns for metal recycling [PB-284855/4] 21 p0201 N79-13152  
Solar Heating And Cooling Of Buildings (SHACOB) commercialization report. Part B: Analysis of market development, volume 2 [BCP/M70066-01/2] 21 p0207 N79-13513  
Assessment of economic factors affecting the satellite power system. Volume 2: The systems implications of rectenna siting issues [NASA-CR-161186] 22 p0368 N79-21552
- LOCKHEED AIRCRAFT SERVICE, INC., ONTARIO, CALIF.**  
An operating 200 kW horizontal axis wind turbine 22 p0240 A79-20829

- LOCKHEED-CALIFORNIA CO., BURBANK.**  
Fuel conservative subsonic transport 22 p0337 N79-16874
- LOCKHEED ELECTRONICS CO., INC., LAS VEGAS, NEV.**  
Remote monitoring of coal strip mine rehabilitation [PB-286647/3] 21 p0228 N79-15379
- LOCKHEED MISSILES AND SPACE CO., PALO ALTO, CALIF.**  
Laser aircraft 22 p0284 A79-26597  
Mechanically rechargeable, metal-air, batteries for automotive propulsion [UCRL-81178] 21 p0189 N79-11538  
Concentrator enhanced solar arrays design study [NASA-CR-158032] 21 p0219 N79-14546  
Laser power conversion system analysis, volume 1 [NASA-CR-159523-VOL-1] 22 p0366 N79-21334  
Laser power conversion system analysis, volume 2 [NASA-CR-159523-VOL-2] 22 p0366 N79-21335
- LOCKHEED MISSILES AND SPACE CO., SUNNYVALE, CALIF.**  
Assessment of SEPS solar array technology for orbital service module application [NASA-CR-151859] 21 p0194 N79-12136  
The 25 kW power module evolution study. Part 3: Conceptual designs for power module evolution. Volume 2: Program plans [NASA-CR-161146] 22 p0345 N79-17890  
Automated array assembly, phase 2. Low-cost solar array project, task 4 [NASA-CR-158365] 22 p0358 N79-20481
- LOS ALAMOS SCIENTIFIC LAB., N. MEX.**  
Hot dry rock energy project [LA-UR-77-2744] 21 p0175 N79-10540  
Thermochemical production of hydrogen from water [LA-UR-78-652] 21 p0180 N79-11236  
Augmented solar energy collection using various planar reflective surfaces: Theoretical calculations and experimental results [LA-7041] 21 p0185 N79-11494  
Thermal stress cracking and the enhancement of heat extraction from fractured geothermal reservoirs [LA-7235-MS] 21 p0198 N79-12568  
Verification methodology for the DOE-1 building energy analysis computer program [LA-UR-78-1493] 21 p0208 N79-13520  
Component-based simulator for solar systems [LA-UR-78-1494] 21 p0208 N79-13521  
Gaseous fuel reactors for power systems [LA-UR-78-1437] 21 p0214 N79-13844  
Trace element characterization and removal/recovery from coal and coal wastes [LA-7048-PR] 21 p0222 N79-14602  
Environmental and radiological safety studies. Interaction of (Pu-238)O<sub>2</sub> heat sources with terrestrial and aquatic environments [LA-7033-PR] 21 p0232 N79-15783  
Toward assessing the geothermal potential of the Jemez Mountains volcanic complex: A telluric-magnetotelluric survey [LA-7656-MS] 22 p0358 N79-20458
- LOUISIANA STATE UNIV. AND A&M COLL., BATON ROUGE.**  
Combustion kinetics of selected aromatic hydrocarbons [AD-A059381] 21 p0215 N79-14184

## M

- MAGNETIC CORP. OF AMERICA, WALTHAM, MASS.**  
Design study of superconducting magnets for a combustion magnetohydrodynamic /MHD/ generator 21 p0084 A79-15305
- MARTIN MARIETTA LABS., BALTIMORE, MD.**  
Biological solar energy conversion approaches to overcome yield stability and product limitations [PB-284823/2] 21 p0199 N79-12577  
Biological solar energy conversion: Approaches to overcome yield, stability and product limitations [PB-286487/4] 21 p0230 N79-15422
- MARYLAND STATE DEPT. OF LEGISLATIVE REFERENCE, ANNAPOLIS.**  
The energy dilemma: A challenge for Maryland. Proceedings Maryland General Assembly/AISLE Conference [PB-284703/6] 21 p0199 N79-12579
- MARYLAND UNIV., COLLEGE PARK.**  
Solar energy pilot study [PB-289380/8] 22 p0363 N79-20525

Report of the 4th CCMS (Committee on the Challenges of Modern Society) Solar Energy Pilot Study Meeting  
[PB-289492/1] 21 p0372 N79-21631

MASSACHUSETTS INST. OF TECH., CAMBRIDGE.  
Alternative aircraft fuels 21 p0033 A79-10824

An assessment of thermal energy storage and waste heat dissipation with total energy systems for MIT  
[AD-A059061] 21 p0205 N79-13502

Present status of GaAs  
[NASA-CR-3093] 21 p0215 N79-14192

The economics and engineering of large-scale algae biomass energy systems  
[PB-287868/4] 21 p0226 N79-15207

Combustion research on the fate of fuel-nitrogen under conditions of pulverized coal combustion  
[PB-286208/4] 21 p0232 N79-15474

Critical contributions in MHD power generation  
[PE-2215-11] 22 p0362 N79-20511

Microcrack technology for geothermal exploration and assessment  
[PB-290173/4] 22 p0367 N79-21530

MASSACHUSETTS UNIV., AMHERST.  
Energy analyses applied to ocean thermal energy conversion and an offshore wind power system  
22 p0353 N79-19442

Two-dimensional analysis of vertical axis windmills 22 p0353 N79-19446

MATTECH, INC., PRINCETON, N. J.  
Impact of electric passenger automobiles on utility system loads, 1985 - 2000  
[EPRI-EA-623] 21 p0203 N79-13281

MAXWELL LABS., INC., WOBURN, MASS.  
Magnetohydrodynamic lightweight channel development  
[AD-A060429] 21 p0230 N79-15414

MCDONNELL AIRCRAFT CO., ST. LOUIS, MO.  
Gironill wind tunnel test and analysis, volume 2. Technical discussion  
[COO-2617-4/2] 21 p0204 N79-13378

MCDONNELL-DOUGLAS ASTRONAUTICS CO., HUNTINGTON BEACH, CALIF.  
The 100 kW space station 22 p0371 N79-21603

MECHANICAL TECHNOLOGY, INC., LATHAM, N. Y.  
Pill type bearings for the Chrysler Automotive Gas Turbine Engine Program - Development and operational experiences  
[SAE PAPER 790109] 22 p0314 A79-31356

MIAMI UNIV., CORAL GABLES, FLA.  
Comparative automotive engine operation when fueled with ethanol and methanol  
[HCP/W1737-01] 21 p0201 N79-13189

MICHIGAN STATE UNIV., EAST LANSING.  
Identification of wood energy resources in central Michigan  
[NASA-CR-158130] 22 p0347 N79-18424

MICHIGAN UNIV., ANN ARBOR.  
Heat flow and radiogenic heat production in Brazil with implications for thermal evolution of continents 22 p0373 N79-21689

MIDWEST RESEARCH INST., KANSAS CITY, MO.  
Solar Heating And Cooling Of Buildings (SHACOB) commercialization report. Part A: Options and strategies. Volume 1: Executive summary  
[HCP/M70065-01/1] 21 p0207 N79-13512

MINNESOTA LEGISLATURE SCIENCE AND TECHNOLOGY PROJECT, ST. PAUL.  
Parameters for legislative consideration of bioconversion technologies  
[PB-284742/4] 21 p0194 N79-12250

MINNESOTA UNIV., MINNEAPOLIS.  
Biomass utilization in Minnesota  
[PB-282531/3] 21 p0171 N79-10241

MISSOURI DEPT OF NATURAL RESOURCES, JEFFERSON CITY.  
LPG in Missouri  
[PB-286329/8] 21 p0230 N79-15421

MITRE CORP., MCLEAN, VA.  
System for projecting the utilization of renewable resources. SPURR methodology  
[ERHQ/2322-77/4] 21 p0174 N79-10538

An assessment of mercury emissions from fossil fueled power plants  
[PB-285227/5] 21 p0213 N79-13592

Lead-acid battery: An evaluation of commercialization strategies  
[MTR-7593] 21 p0220 N79-14565

MOBIL TYCO SOLAR ENERGY CORP., WALTHAM, MASS.  
Large area silicon sheet by EPG 21 p0123 A79-17340

Large area silicon sheet by EPG  
[NASA-CR-158379] 22 p0359 N79-20483

MONSANTO RESEARCH CORP., DAYTON, OHIO.  
Particulate control mobile test units: Third year's operation  
[PB-283657/5] 21 p0178 N79-10603

Source assessment: Water pollutants from coal storage areas  
[PB-285420/6] 21 p0223 N79-14635

Energy requirements of present pollution control technology  
[PB-286231/6] 21 p0223 N79-14643

Source assessment: Open mining of coal. State of the Art  
[PB-288497/1] 22 p0353 N79-19429

MONTANA ENERGY AND MBE RESEARCH AND DEVELOPMENT INST., INC., BUTTE.  
MHD power generation: Research, development and engineering  
[PE-2524-8] 22 p0363 N79-20517

MHD power generation: Research, development and engineering  
[PE-3087-2] 22 p0363 N79-20518

MOTOROLA, INC., PHOENIX, ARIZ.  
Phase 1 of the automated array assembly task of the low cost silicon solar array project  
[NASA-CR-158120] 22 p0348 N79-18451

MUELLER ASSOCIATES, INC., BALTIMORE, MD.  
Denaturants for ethanol/gasoline blends  
[HCP/M2098-01] 21 p0180 N79-11237

Status of alcohol fuels utilization technology for highway transportation  
[HCP/M2923-01] 21 p0201 N79-13190

MUNICIPAL ENVIRONMENTAL RESEARCH LAB., CINCINNATI, OHIO.  
Total energy consumption for municipal wastewater treatment  
[PB-286688/7] 21 p0231 N79-15439

## N

NALCO ENVIRONMENTAL SCIENCES, NORTHBROOK, ILL.  
Atlas of western surface-mined lands: Coal, uranium, and phosphate  
[PB-287846/0] 22 p0340 N79-17311

NATIONAL ACADEMY OF SCIENCES - NATIONAL RESEARCH COUNCIL, WASHINGTON, D. C.  
Methane generation from human, animal, and agricultural wastes  
[PB-276469/4] 21 p0171 N79-10240

Strategies for applied research management  
[PB-284741/6] 21 p0214 N79-13913

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION, WASHINGTON, D. C.  
Satellite power systems /SPS/ overview  
21 p0002 A79-10022

NASA's thermionic technology program  
21 p0026 A79-10217

Evolution of space power systems  
[IAF PAPER 78-43] 21 p0035 A79-11218

High efficiency low cost solar cell power  
21 p0048 A79-12471

Technology for aircraft energy efficiency  
21 p0066 A79-14136

Space power for space  
21 p0100 A79-16143

Overview of future programs - USA  
21 p0116 A79-17275

Space solar power - An energy alternative  
22 p0303 A79-29796

The NASA Aircraft Energy Efficiency program  
22 p0325 A79-31912

OAST space power technology program  
21 p0169 N79-10123

Satellite power systems program  
21 p0169 N79-10128

Program THEK energy production units of average power and using thermal conversion of solar radiation  
[NASA-TN-75369] 21 p0183 N79-11474

The sterling engine for vehicle propulsion  
[NASA-TN-75442] 21 p0195 N79-12547



# CORPORATE SOURCE INDEX

Statement of Doctor Robert A. Prosch,  
Administrator, National Aeronautics and Space  
Administration 21 p0224 N79-15111

Hydrogen technology from thermonuclear research 22 p0338 N79-16997

NACA research on hydrogen for high altitude  
aircraft 22 p0338 N79-16999

New initiatives in high altitude aircraft 22 p0338 N79-17000

Dependence of the pour point of diesel fuels on  
the properties of the initial components  
[NASA-TM-75424] 22 p0364 N79-21217

Satellite power system: Concept development and  
evaluation program, reference system report  
[NASA-TM-80413] 22 p0367 N79-21538

NASA's OAST program: An overview 22 p0370 N79-21574

**NATIONAL AERONAUTICS AND SPACE ADMINISTRATION. AMES  
RESEARCH CENTER, HOPPETT FIELD, CALIF.**

Enhanced solar energy options using  
earth-orbiting mirrors 21 p0019 A79-10162

Simulation study of the effect of  
fuel-conservative approaches on ATC procedures  
and terminal area capacity  
[SAE PAPER 780523] 21 p0031 A79-10398

Orbiting mirrors for terrestrial energy supply 21 p0108 A79-16605

A search for space energy alternatives 21 p0108 A79-16608

Systems efficiency and specific mass estimates  
for direct and indirect solar-pumped  
closed-cycle high-energy lasers in space 21 p0110 A79-16623

Status and summary of laser energy conversion 21 p0111 A79-16635

Dynamic simulation studies of fuel conservation  
procedures used in terminal areas 22 p0259 A79-23581

Some perspectives on research into the  
biological response to non-ionizing  
electromagnetic radiation 22 p0271 A79-24879

Space reflector technology and its system  
implications  
[AIAA PAPER 79-0545] 22 p0273 A79-25852

Radiation energy conversion in space 22 p0284 A79-26595

Nonlinear dynamic response of wind turbine rotors  
[NASA-TM-78324] 21 p0195 N79-12542

Transient shutdown analysis of low-temperature  
thermal diodes  
[NASA-TM-1369] 22 p0346 N79-18287

**NATIONAL AERONAUTICS AND SPACE ADMINISTRATION.  
GODDARD SPACE FLIGHT CENTER, GREENBELT, MD.**

Energy and remote sensing applications 22 p0255 A79-22516

Battery workshop 21 p0170 N79-10143

The natural and perturbed troposphere 21 p0179 N79-10636

Changes in the terrestrial  
atmosphere-ionosphere-magnetosphere system due  
to ion propulsion for solar power satellite  
placement  
[NASA-TM-79719] 22 p0345 N79-17897

Baltimore applications project  
[NASA-TM-79667] 22 p0351 N79-18815

Solar cell module assembly jig  
[NASA-CASE-XGS-00829-1] 22 p0353 N79-19447

The 1977 Goddard Space Flight Center Battery  
Workshop  
[NASA-CP-2041] 22 p0370 N79-21565

Synchronous meteorological and geostationary  
operational environmental satellites battery  
and power system design 22 p0370 N79-21571

Accelerated test program 22 p0370 N79-21577

**NATIONAL AERONAUTICS AND SPACE ADMINISTRATION.  
LYNDON B. JOHNSON SPACE CENTER, HOUSTON, TEX.**

Environmental considerations for the microwave  
beam from a solar power satellite 21 p0003 A79-10030

A technology program for large area space systems 21 p0100 A79-16145

# NATIONAL AERONAUTICS AND SPACE ADMINISTRATION.

The solar power satellite concept evaluation  
program 21 p0107 A79-16602

Design considerations for solar power satellites 21 p0113 A79-16738

The solar power satellite concept - The past  
decade and the next decade  
[AIAA PAPER 79-0534] 22 p0273 A79-25854

Solar power satellite 22 p0287 A79-27375

The Solar Power Satellite concept - Towards the  
future 22 p0327 A79-31925

Technology status: Fuel cells and electrolysis  
cells 21 p0170 N79-10133

**NATIONAL AERONAUTICS AND SPACE ADMINISTRATION. JOHN  
F. KENNEDY SPACE CENTER, COCOA BEACH, FLA.**

Identification of cost effective energy  
conservation measures 21 p0099 A79-16133

**NATIONAL AERONAUTICS AND SPACE ADMINISTRATION.  
LANGLEY RESEARCH CENTER, HAMPTON, VA.**

Detection of internal defects in a liquid  
natural gas tank by use of infrared thermography 21 p0048 A79-12507

Alternate aircraft fuels prospects and  
operational implications 21 p0066 A79-14138

A technology program for large area space systems 21 p0100 A79-16145

Recent advances in convectively cooled engine  
and airframe structures for hypersonic flight 21 p0165 A79-20087

Investigation of a staged plasma-focus apparatus 22 p0255 A79-22365

Advanced air transport concepts 22 p0312 A79-31121

Future large space systems opportunities: A  
case for space-to-space power? 21 p0169 N79-10095

Elemental characteristics of aerosols emitted  
from a coal-fired heating plant  
[NASA-TM-78749] 21 p0191 N79-11560

OAST Space Theme Workshop. Volume 1: Summary  
report. 1: Introduction. 2: General  
observations and some key findings. 3:  
Follow-on activity. Quick-look comments and  
working papers  
[NASA-TM-80001] 21 p0224 N79-15113

OAST Space Theme Workshop. Volume 2: Theme  
summary. 1: Space power (no. 7). A. Theme  
statement. B. 26 April 1976 presentation.  
C. Summary. D. Initiative action  
[NASA-TM-80002] 21 p0225 N79-15114

OAST Space Theme Workshop. Volume 3: Working  
group summary. 6: Power (P-2). A. Theme  
Statement. B. Technology needs (for a 1). C.  
Priority assessment (for a 2)  
[NASA-TM-80013] 21 p0225 N79-15125

General aviation energy-conservation research  
programs 22 p0329 N79-15963

Engine requirements for future general aviation  
aircraft 22 p0329 N79-15968

**NATIONAL AERONAUTICS AND SPACE ADMINISTRATION.  
LEWIS RESEARCH CENTER, CLEVELAND, OHIO.**

Status of wraparound contact solar cells and  
arrays 21 p0001 A79-10014

Rapid, efficient charging of lead-acid and  
nickel-zinc traction cells 21 p0009 A79-10084

Response of lead-acid batteries to  
chopper-controlled discharge 21 p0011 A79-10097

Thermal energy storage for industrial waste heat  
recovery 21 p0012 A79-10101

Storage systems for solar thermal power 21 p0013 A79-10108

Lithium and potassium heat pipes for thermionic  
converters 21 p0013 A79-10113

Design and operating experience on the U.S.  
Department of Energy Experimental Mod-0 100 kW  
Wind Turbine 21 p0028 A79-10234

DOE/NASA Mod-OA wind turbine performance  
21 p0028 A79-10235  
SIMWEST - A simulation model for wind energy  
storage systems  
21 p0029 A79-10241  
Alternative aircraft fuels  
21 p0033 A79-10824  
Effect of inlet temperature on the performance  
of a catalytic reactor  
21 p0035 A79-11542  
An improved method for analysis of hydroxide and  
carbonate in alkaline electrolytes containing  
zinc  
21 p0035 A79-11546  
Characteristics and combustion of future  
hydrocarbon fuels  
21 p0036 A79-11599  
Impact of future fuel properties on aircraft  
engines and fuel systems  
21 p0036 A79-11600  
Factors affecting the open-circuit voltage and  
electrode kinetics of some iron/titanium/redox  
flow cells  
21 p0040 A79-11824  
Alternative aviation turbine fuels  
21 p0047 A79-12378  
Ceramics for the advanced automotive gas turbine  
engine - A look at a single shaft design  
21 p0050 A79-12850  
Ceramic applications in the advanced Stirling  
automotive engine  
21 p0051 A79-12851  
Diminide thermionic energy conversion with  
lanthanum-hexaboride electrodes  
21 p0053 A79-13098  
NASA Lewis Research Center photovoltaic  
application experiments  
[AIAA PAPER 78-1768]  
21 p0061 A79-13867  
Fuel cell on-site integrated energy system  
parametric analysis of a residential complex  
21 p0081 A79-14947  
Correlations of catalytic combustor performance  
parameters  
21 p0081 A79-14956  
Design study of superconducting magnets for a  
combustion magnetohydrodynamic (MHD) generator  
21 p0084 A79-15305  
Control of wind turbine generators connected to  
power systems  
21 p0086 A79-15574  
Large wind turbine generators  
21 p0092 A79-15881  
Fuel conservative aircraft engine technology  
21 p0164 A79-20078  
Energy conservation through sealing technology  
22 p0237 A79-20700  
Wind-turbine-generator rotor-blade concepts with  
low-cost potential  
22 p0240 A79-20828  
An operating 200 kW horizontal axis wind turbine  
22 p0240 A79-20829  
Thermal storage for industrial process and  
reject heat  
22 p0243 A79-21300  
Microprocessor control of a wind turbine generator  
22 p0244 A79-21302  
Evaluation of the application of some gas  
chromatographic methods for the determination  
of properties of synthetic fuels  
22 p0274 A79-25917  
Photovoltaic power systems for rural areas of  
developing countries  
22 p0278 A79-26131  
Velocity, temperature, and electrical  
conductivity profiles in hydrogen-oxygen MHD  
duct flows  
22 p0279 A79-26184  
Burn coal cleanly in a fluidized bed - The key  
is in the controls  
22 p0282 A79-26374  
Evaluation of HOSTAS computer code for  
predicting dynamic loads in two-bladed wind  
turbines  
[AIAA 79-0733]  
22 p0298 A79-29007  
Effect of broadened-specification fuels on  
aircraft engines and fuel systems  
[AIAA 79-7008]  
22 p0300 A79-29383

Benefits of solar/fossil hybrid gas turbine  
systems  
[ASME PAPER 79-GT-38]  
22 p0309 A79-30554  
High-freezing-point fuels used for aviation  
turbine engines  
[ASME PAPER 79-GT-141]  
22 p0309 A79-30555  
Initial comparison of single cylinder Stirling  
engine computer model predictions with test  
results  
[SAE PAPER 790327]  
22 p0315 A79-31368  
Future Orbital Power Systems Technology  
Requirements  
[NASA-CP-2058]  
21 p0169 N79-10122  
Alternative power-generation systems  
21 p0169 N79-10129  
Technology status: Batteries and fuel cells  
21 p0170 N79-10132  
Power management and control for space systems  
21 p0170 N79-10134  
An economical approach to space power systems  
21 p0170 N79-10139  
Solar cells having integral collector grids  
[NASA-CASE-LEW-12819-1]  
21 p0182 N79-11467  
Solar cell collector and method for producing same  
[NASA-CASE-LEW-12552-2]  
21 p0182 N79-11472  
Optimum dry-cooling sub-systems for a solar air  
conditioner  
[NASA-TM-79007]  
21 p0183 N79-11477  
Preliminary summary of the ETF conceptual studies  
[NASA-TM-78999]  
21 p0183 N79-11478  
Supply of reactants for Redox bulk energy  
storage systems  
[NASA-TM-78995]  
21 p0183 N79-11479  
Thermal storage for industrial process and  
reject heat  
[NASA-TM-78994]  
21 p0183 N79-11481  
Fuel cell on-site integrated energy system  
parametric analysis of a residential complex  
[NASA-TM-78996]  
21 p0193 N79-11955  
NASA research on general aviation power plants  
[NASA-TM-79031]  
21 p0194 N79-12086  
Microprocessor control of a wind turbine generator  
[NASA-TM-79021]  
21 p0195 N79-12548  
Characteristics and combustion of future  
hydrocarbon fuels  
21 p0202 N79-13196  
Impact of future fuel properties on aircraft  
engines and fuel systems  
21 p0202 N79-13197  
Application of multispectral scanner data to the  
study of an abandoned surface coal mine  
[NASA-TM-78912]  
21 p0204 N79-13472  
Effect of swirler-mounted mixing venturi on  
emissions of flame-tube combustor using jet A  
fuel  
[NASA-TP-1393]  
21 p0215 N79-14099  
Back wall solar cell  
[NASA-CASE-LEW-12236-2]  
21 p0217 N79-14528  
Some heat transfer and hydrodynamic problems  
associated with superconducting cables (SPTL)  
[NASA-TM-79023]  
21 p0226 N79-15267  
Comparison of fuel-cell and diesel integrated  
energy systems and a conventional system for a  
500-unit apartment  
[NASA-TM-79037]  
21 p0229 N79-15403  
Benefits of solar/fossil hybrid gas turbine  
systems  
[NASA-TM-79083]  
21 p0229 N79-15410  
Photovoltaic power systems for rural areas of  
developing countries  
[NASA-TM-79097]  
21 p0229 N79-15411  
The rotary combustion engine: A candidate for  
general aviation  
[NASA-CP-2067]  
22 p0329 N79-15961  
Effect of broadened-specification fuels on  
aircraft engines and fuel systems  
[NASA-TM-79086]  
22 p0330 N79-16136  
Power train analysis for the DOE/NASA 100-kW  
wind turbine generator  
[NASA-TM-78997]  
22 p0333 N79-16355  
An operating 200-kW horizontal axis wind turbine  
[NASA-TM-79034]  
22 p0333 N79-16357  
Initial comparison of single cylinder Stirling  
engine computer model predictions with test  
results  
[NASA-TM-79044]  
22 p0337 N79-16721

- Evaluation of the application of some gas chromatographic methods for the determination of properties of synthetic fuels  
[NASA-TN-79035] 22 p0338 N79-16930
- A 200-kW wind turbine generator conceptual design study  
[NASA-TN-79032] 22 p0341 N79-17333
- Evaluation of the ECAS open cycle HHD power plant design  
[NASA-TN-79012] 22 p0341 N79-17335
- Photovoltaic tests and applications project  
[NASA-TN-79018] 22 p0342 N79-17336
- Cold-air performance of free power turbine designed for 112-kilowatt automotive gas-turbine engine. 2: Effects of variable stator-vane-chord setting angle on turbine performance  
[NASA-TN-78993] 22 p0345 N79-17859
- Parametric performance of a turbojet engine combustor using jet A and A diesel fuel  
[NASA-TN-79089] 22 p0357 N79-20114
- Tests of NASA ceramic thermal barrier coating for gas-turbine engines  
[NASA-TN-79116] 22 p0357 N79-20118
- Closed Loop solar array-ion thruster system with power control circuitry  
[NASA-CASE-LEW-12780-1] 22 p0357 N79-20179
- Utility operational experience on the NASA/DOE MOD-OA 200-kW wind turbine  
[NASA-TN-79084] 22 p0360 N79-20494
- Thermal storage technologies for solar industrial process heat applications  
[NASA-TN-79130] 22 p0360 N79-20498
- Evaluation of MOSTAS computer code for predicting dynamic loads in two bladed wind turbines  
[NASA-TN-79101] 22 p0368 N79-21549
- The role of thermal energy storage in industrial energy conservation  
[NASA-TN-79122] 22 p0368 N79-21550
- Levis Research Center program  
22 p0370 N79-21576
- NATIONAL AERONAUTICS AND SPACE ADMINISTRATION.**  
**MARSHALL SPACE FLIGHT CENTER, HUNTSVILLE, ALA.**
- Status of wraparound contact solar cells and arrays  
21 p0001 A79-10014
- Selling solar energy as a cash crop  
21 p0049 A79-12725
- The Solar Heating and Cooling Commercial Demonstration Program at Marshall Space Flight Center - Some problems and conclusions  
21 p0099 A79-16135
- Solar thermal collectors using planar reflector  
21 p0131 A79-17412
- An approach to automated longwall mining  
[AIAA PAPER 79-0532] 22 p0274 A79-25871
- Solar array systems  
21 p0169 N79-10131
- Rotatable mass for a flywheel  
[NASA-CASE-MFS-23051-1] 21 p0172 N79-10422
- Solar tracking control system Sun Chaser  
[NASA-TN-78199] 21 p0172 N79-10514
- Cost analysis of new and retrofit hot-air type solar assisted heating systems  
[NASA-TN-78186] 21 p0173 N79-10519
- Rankine cycle machines for solar cooling  
[NASA-TN-78196] 21 p0173 N79-10524
- Method for making an aluminum or copper substrate panel for selective absorption of solar energy  
[NASA-CASE-MFS-23518-1] 21 p0182 N79-11469
- HSPC hot air collectors  
[NASA-TN-78206] 21 p0196 N79-12556
- FY 1978 scientific and technical reports, articles, papers, and presentations  
[NASA-TN-78203] 21 p0214 N79-13915
- Summary of atmospheric wind design criteria for wind energy conversion system development  
[NASA-TP-1389] 21 p0223 N79-14678
- Engineering handbook on the atmospheric environmental guidelines for use in wind turbine generator development  
[NASA-TP-1359] 21 p0223 N79-14679
- The 25 kW power module updated baseline system  
[NASA-TN-78212] 21 p0226 N79-15247
- Development, testing, and certification of Calmac Mfg. Corp. solar collector and solar operated pump  
[NASA-TN-78218] 22 p0342 N79-17338
- Performance characteristics of a 1.8 by 3.7 meter Fresnel lens solar concentrator  
[NASA-TN-78222] 22 p0360 N79-20495
- Development, testing, and certification of the Northrup, Inc., NL series concentrating solar collector model NSC-01-0732  
[NASA-TN-78219] 22 p0371 N79-21618
- Development, testing, and certification of Owens-Illinois model SEC-601 solar energy collector system  
[NASA-TN-78223] 22 p0371 N79-21620
- NATIONAL AERONAUTICS AND SPACE ADMINISTRATION.**  
**PASADENA OFFICE, CALIF.**
- Dual membrane hollow fiber fuel cell and method of operating same  
[NASA-CASE-NPO-13732-1] 21 p0172 N79-10513
- Surfactant-assisted liquefaction of particulate carbonaceous substances  
[NASA-CASE-NPO-13904-1] 21 p0179 N79-11152
- Solar photolysis of water  
[NASA-CASE-NPO-14126-1] 21 p0182 N79-11470
- Non-tracking solar energy collector system  
[NASA-CASE-NPO-13817-1] 21 p0182 N79-11471
- Primary reflector for solar energy collection systems  
[NASA-CASE-NPO-13579-4] 21 p0217 N79-14529
- Thermal energy transformer  
[NASA-CASE-NPO-14058-1] 22 p0348 N79-18443
- An improved solar panel and method for fabricating the same  
[NASA-CASE-NPO-14490-1] 22 p0348 N79-18445
- Electromagnetic radiation energy arrangement  
[NASA-CASE-WOO-00428-1] 22 p0352 N79-19186
- Borehole geological assessment  
[NASA-CASE-NPO-14231-1] 22 p0356 N79-19521
- An improved solar energy receiver for a stirling engine  
[NASA-CASE-NPO-14619-1] 22 p0362 N79-20513
- NATIONAL ASSOCIATION OF COUNTIES, WASHINGTON, D. C.**
- Guide to reducing energy-use budget costs  
[HCP/U60505-01] 21 p0184 N79-11489
- NATIONAL AVIATION FACILITIES EXPERIMENTAL CENTER, ATLANTIC CITY, N. J.**
- Simulation study of the effect of fuel-conservative approaches on ATC procedures and terminal area capacity  
[SAE PAPER 780523] 21 p0031 A79-10398
- Dynamic simulation studies of fuel conservation procedures used in terminal areas  
22 p0259 A79-23581
- Alternative energy sources for Federal Aviation Administration facilities  
[AD-A058681] 21 p0196 N79-12555
- NATIONAL BUREAU OF STANDARDS, WASHINGTON, D. C.**
- Plan for the development and implementation of standards for solar heating and cooling applications  
[PB-283237/6] 21 p0190 N79-11543
- International project catalog of modular integrated utility systems  
[PB-283477/8] 21 p0190 N79-11544
- Committee on the Challenges of Modern Society Rational use of Energy Pilot Study Modular Integrated Utility Systems Project. Volume 1: Description, activities, and products  
[PB-283428/1] 21 p0190 N79-11549
- Committee on the challenges of modern society rational use of energy pilot study modular integrated utility system project. Volume 2: Minutes of project meeting  
[PB-283429/9] 21 p0191 N79-11558
- Provisional flat plate solar collector testing procedures  
[PB-283721/9] 21 p0198 N79-12571
- An annotated compilation of the sources of information related to the usage of electricity in non-industrial applications  
[PB-285260/6] 21 p0212 N79-13552
- Materials for fuel cells  
[PB-285360/4] 21 p0212 N79-13553
- The effects of resource impact factors on energy conservation standards for buildings  
[PB-286909/7] 22 p0335 N79-16384

Environmental and safety considerations for solar heating and cooling applications [PB-287772/8] 22 p0343 N79-17350

State-of-the-art study of heat exchangers used with solar assisted domestic hot water systems (potential contamination of potable water supply) [PB-287410/5] 22 p0343 N79-17351

Measurement techniques for solar cells [PB-287519/3] 22 p0343 N79-17352

Life-cycle costing. A guide for selecting energy conservation projects for public buildings [PB-287804/9] 22 p0345 N79-17744

Geographical variation in the heating and cooling requirements of a typical single-family house, and correlation of these requirements to degree days [PB-289204/0] 22 p0355 N79-19467

Solar building regulatory study, volume 2 [PB-289824/5] 22 p0357 N79-20291

Laboratories technically qualified to test solar collectors in accordance with ASHRAE standard 93-77: A summary report [PB-289729/6] 22 p0363 N79-20524

Test procedures for the determination of the gross caloric value of refuse and refuse-derived-fuels by oxygen bomb calorimetry: Summary of the 1977 fiscal year results [PB-290160/1] 22 p0364 N79-21167

Interim performance criteria for solar heating and cooling systems in residential buildings, second edition [PB-289967/2] 22 p0372 N79-21630

Experimental verification of a standard test procedure for solar collectors [PB-289912/8] 22 p0372 N79-21632

NATIONAL CENTER FOR ATMOSPHERIC RESEARCH, BOULDER, COLO.

Multidisciplinary research related to the atmospheric sciences [PB-283076/8] 21 p0179 N79-10679

NATIONAL INST. OF BUILDING SCIENCES, WASHINGTON, D. C.

Solar building regulatory study, volume 1 [PB-289823/7] 22 p0365 N79-21235

NATIONAL LEAGUE OF CITIES, WASHINGTON, D. C.

Guide to reducing energy-use budget costs [HCP/U60505-01] 21 p0184 N79-11489

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION, BOULDER, COLO.

Environmental assessment of the Alaskan Continental Shelf. Volume 1: Biological studies [PB-289154/7] 22 p0344 N79-17366

Environmental assessment of the Alaskan Continental Shelf. Volume 2: Biological studies [PB-289155/4] 22 p0344 N79-17367

Environmental assessment of the Alaskan Continental Shelf. Volume 3: Biological studies [PB-289156/2] 22 p0344 N79-17368

Marine biological effects of OCS petroleum development [PB-288935/0] 22 p0344 N79-17374

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION, WASHINGTON, D. C.

Harnessing tidal energy [PB-286671/3] 21 p0222 N79-14581

NATIONAL TECHNICAL INFORMATION SERVICE, SPRINGFIELD, VA.

Electric automobiles. Citations from the NTIS data base [NTIS/PS-78/0880/1] 21 p0171 N79-10363

Electric automobiles, volume 2. Citations from the engineering index data base [NTIS/PS-78/0881/9] 21 p0172 N79-10364

Energy conservation: Policies, programs and general studies. A bibliography with abstracts [NTIS/PS-78/0693/8] 21 p0176 N79-10552

Solar ponds. Citations from the NTIS data base [NTIS/PS-78/0836/3] 21 p0176 N79-10553

Solar ponds. Citations from the engineering index data base [NTIS/PS-78/0837/1] 21 p0176 N79-10554

Solar energy concentrator design and operation. Citations from the NTIS data base [NTIS/PS-78/0838/9] 21 p0178 N79-10566

Technology assessment, volume 2. A bibliography with abstracts [NTIS/PS-78/0830/6] 21 p0179 N79-10951

Design and applications of flywheels. Citations from the NTIS data base [NTIS/PS-78/0997/3] 21 p0190 N79-11550

Design and applications of flywheels. Citations from the engineering index data base [NTIS/PS-78/0998/1] 21 p0190 N79-11551

Energy policy and research planning, volume 2. A bibliography with abstracts [NTIS/PS-78/0961/9] 21 p0191 N79-11552

Energy policy and research planning, volume 3. A bibliography with abstracts [NTIS/PS-78/0962/7] 21 p0191 N79-11553

Nitrogen oxide air pollution. Volume 2, part 1: Control technology. A bibliography with abstracts [NTIS/PS-78/0971/8] 21 p0199 N79-12591

Nitrogen oxide air pollution. Part 3: Atmospheric chemistry. A bibliography with abstracts [NTIS/PS-78/0973/4] 21 p0199 N79-12593

Solar space heating and air conditioning, volume 2. Citations from the NTIS data base [NTIS/PS-78/1014/6] 21 p0211 N79-13545

Solar space heating and air conditioning volume 3. Citations from the NTIS data base [NTIS/PS-78/1015/3] 21 p0211 N79-13546

Solar space heating and air conditioning, volume 3. Citations from the engineering index data base [NTIS/PS-78/1017/9] 21 p0211 N79-13547

Solar space heating and air conditioning, volume 2. Citations from the engineering index data base [NTIS/PS-78/1016/1] 21 p0212 N79-13550

Flat plate solar collector design and performance. Citations from the NTIS data base [NTIS/PS-78/0840/5] 21 p0212 N79-13551

Silicon solar cells, volume 2. Citations from the NTIS data base [NTIS/PS-78/1114/4] 21 p0212 N79-13554

Silicon solar cells, volume 3. Citations from the NTIS data base [NTIS/PS-78/1115/1] 21 p0212 N79-13555

Silicon solar cells, volume 2. Citations from the NTIS data base [NTIS/PS-78/1116/9] 21 p0212 N79-13556

Solar electric power generation, volume 2. Citations from the NTIS data base [NTIS/PS-78/1108/6] 21 p0212 N79-13557

Solar electric power generation, volume 2. Citations from the Engineering Index data base [NTIS/PS-78/1109/4] 21 p0212 N79-13558

Combined cycle power generation. Citations from the NTIS data base [NTIS/PS-78/1156/5] 21 p0222 N79-14587

Combined cycle power generation. Citations from the Engineering Index data base [NTIS/PS-78/1157/3] 21 p0222 N79-14588

Cadmium sulfide solar cells. Citations from the NTIS data base [NTIS/PS-78/1213/4] 21 p0231 N79-15436

Cadmium sulfide solar cells. Citations from the Engineering Index data base [NTIS/PS-78/1214/2] 21 p0231 N79-15437

Cryogenic refrigeration, volume 2. A bibliography with abstracts [NTIS/PS-78/1261/3] 22 p0331 N79-16144

Cryogenic refrigeration, volume 3. A bibliography with abstracts [NTIS/PS-78/1262/1] 22 p0331 N79-16145

Solar water pumps. Citations from the Engineering Index data base [NTIS/PS-78/1288/6] 22 p0343 N79-17348

Optical coatings for solar cells and solar collectors. Citations from the NTIS data base [NTIS/PS-78/1341/3] 22 p0350 N79-18465

Optical coatings for solar cells and solar collectors. Citations from the Engineering index data base [NTIS/PS-78/1342/1] 22 p0350 N79-18466

Synthetic fuels: Methane. Citations from the Engineering Index data base [NTIS/PS-79/0030/1] 22 p0365 N79-21223

NATO COMMITTEE ON THE CHALLENGES OF MODERN SOCIETY,  
BRUSSELS (BELGIUM).Solar energy pilot study  
[PB-289380/8] 22 p0363 N79-20525Report of the 4th CCMS (Committee on the  
Challenges of Modern Society) Solar Energy  
Pilot Study Meeting

[PB-289492/1] 22 p0372 N79-21631

## NAVAL AIR SYSTEMS COMMAND, WASHINGTON, D. C.

Naval Air Systems Command-Naval Research  
Laboratory Workshop on Basic Research Needs  
for Synthetic Hydrocarbon Jet Aircraft Fuels  
[AD-A060081] 21 p0216 N79-14235

## NAVAL POSTGRADUATE SCHOOL, MONTEREY, CALIF.

Preliminary design and analysis of a total  
energy system for Massachusetts Institute of  
Technology

[AD-A057289] 21 p0184 N79-11486

## NAVAL RESEARCH LAB., WASHINGTON, D. C.

Further studies of fuels from alternate sources:  
Fire extinguishment experiments with JP-5 jet  
turbine fuel derived from shale

[AD-A058586] 21 p0201 N79-13182

Aging behavior of crude shale oil  
[AD-A062420] 22 p0357 N79-20272

## NEBRASKA UNIV. - LINCOLN.

Parameter estimation and validation of a solar  
assisted heat pump model

22 p0332 N79-16349

## NEW MEXICO ENERGY INST., ALBUQUERQUE.

Methane production from carbon oxides over  
borohydride-reduced transition metals.

[PB-286385/0] 21 p0226 N79-15177

NEW ZEALAND ENERGY RESEARCH AND DEVELOPMENT  
COMMITTEE, AUCKLAND.

Energy scenarios: Supplementary studies

[NP-23292] 21 p0211 N79-13543

NORTH CAROLINA SCIENCE AND TECHNOLOGY RESEARCH  
CENTER, RESEARCH TRIANGLE PARK.An analytical investigation of the performance  
of solar collectors as nighttime heat  
radiators in airconditioning cycles

[NASA-CR-3111] 22 p0363 N79-20519

## NORTHERN, INC., HUTCHINS, TEX.

Design package for concentrating solar collector  
panels

[NASA-CR-150788] 21 p0173 N79-10523

## NORTHWEST ENERGY POLICY PROJECT, PORTLAND, OREG.

Energy future Northwest: Northwest Energy

Policy project

[PB-284697/0] 21 p0199 N79-12578

## NORTHWESTERN UNIV., EVANSTON, ILL.

Stochastic analysis of wind characteristics for

energy conversion

22 p0350 N79-18535

## NOTRE DAME UNIV., IND.

Catalytic effect of Ni and K<sub>2</sub>CO<sub>3</sub> in the  
gasification of carbon and coal

22 p0364 N79-21215

## NUCLEAR REGULATORY COMMISSION, WASHINGTON, D. C.

Coal and nuclear: A comparison of the cost of  
generating baseload electricity by region

[PB-289585/2] 22 p0355 N79-19469

## O

## OAK RIDGE ASSOCIATED UNIVERSITIES, TENN.

Net energy analysis of five energy systems

[ORAU/IEA(B)-77-12] 21 p0174 N79-10534

Coal research: Data systems and information

transfer

[ORAU-133] 21 p0232 N79-15830

## OAK RIDGE NATIONAL LAB., TENN.

Thermal energy storage for industrial waste heat

recovery

21 p0012 N79-10101

Energy availabilities for state and local

development: 1973 data volume

[ORNL/TM-5890-S2] 21 p0175 N79-10541

Energy availabilities for state and local

development: 1974 data volume

[ORNL/TM-5890-S3] 21 p0175 N79-10542

Transportation Energy Conservation Data Book,

edition 2

[ORNL-5320] 21 p0184 N79-11487

Energy availabilities for state and local

development: Projected energy patterns for

1980 and 1985

[ORNL/TM-5890/S4] 21 p0186 N79-11511

Energy-related pollutants in the environment:

The use of short-term for mutagenicity in the

isolation and identification of biohazards

[CONF-780121-2] 21 p0192 N79-11568

Nonproliferation Alternative Systems Assessment

Program (NASAP): Preliminary environmental

assessment of thorium/uranium fuel cycle systems

[ORNL/TM-6069] 21 p0192 N79-11570

Proliferation-resistant nuclear fuel cycles

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MUS applications

[ORNL/HD/MUS-32] 21 p0220 N79-14564

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[ORNL/HD/MUS-33] 21 p0221 N79-14575

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[ORNL-5363] 22 p0348 N79-18447

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[PB-283104/8] 21 p0191 N79-11556

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Application of solar technology to today's

energy needs, volume 2

[OTA-E-77-VOL-2] 21 p0218 N79-14530

Analytical methods

21 p0218 N79-14531

Current and projected fuel costs

21 p0218 N79-14532

Calculation of backup requirements

21 p0218 N79-14533

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21 p0218 N79-14534

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21 p0218 N79-14535

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22 p0336 N79-16704

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22 p0255 N79-22365

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TENNESSEE UNIV., KNOXVILLE.  
Energy conservation through sealing technology  
22 p0237 A79-20700  
Accuracy analysis of pointing control system of solar power station  
[NASA-CR-150880] 21 p0215 N79-14143  
TENNESSEE UNIV. SPACE INST., TULLAHOCA.  
Applying NASA remote sensing data to geologically related regional planning problems in Tennessee  
[E79-10095] 22 p0339 N79-17289  
TETRA TECH, INC., ARLINGTON, VA.  
US Navy energy plan and program, 1978  
[AD-A058054] 21 p0197 N79-12560  
TEXAS UNIV. AT AUSTIN.  
Solid desiccant air conditioning with silica gel using solar energy  
21 p0181 N79-11464  
Energy and economic analysis of industrial process heat recovery with heat pumps  
22 p0331 N79-16210  
THERMO ELECTRON CORP., WALTHAM, MASS.  
Lithium and potassium heat pipes for thermionic converters  
21 p0013 A79-10113  
THOMPSON RANO WOOLDRIDGE, INC., CLEVELAND, OHIO.  
Electromagnetic radiation energy arrangement  
[NASA-CASE-WOO-00428-1] 22 p0352 N79-19186  
TOLEDO UNIV., OHIO.  
Evaluation of MOSTAS computer code for predicting dynamic loads in two-bladed wind turbines  
[AIAA 79-0733] 22 p0298 A79-29007  
Transient response to three-phase faults on a wind turbine generator  
21 p0180 N79-11312  
TOYO KOGYO CO. LTD., HIROSHIMA (JAPAN).  
Development status of rotary engine at Toyo Kogyo  
22 p0329 N79-15964  
TRANSPORTATION RESEARCH BOARD, WASHINGTON, D. C.  
Environmental conservation concerns in transportation: Energy, noise, and air quality  
[PB-286550/9] 21 p0232 N79-15868  
TRANSPORTATION SYSTEMS CENTER, CAMBRIDGE, MASS.  
The emissions and fuel economy of a Detroit diesel 6-71 engine burning a 10-percent water-in-fuel emulsion  
[AD-A058550] 21 p0203 N79-13375  
Proceedings of symposium on water-in-fuel emulsions in combustion  
[AD-A061503] 22 p0338 N79-17019  
TRW DEFENSE AND SPACE SYSTEMS GROUP, REDONDO BEACH, CALIF.  
Solar array workshop  
21 p0170 N79-10142  
Catalytic conversion of coal energy to hydrogen  
[FE-2206-14] 21 p0180 N79-11239  
High pressure MHD coal combustors investigation  
[FE-2706-08] 22 p0362 N79-20510

TRW, INC., DURHAM, N. C.  
Evaluation of dry sorbents and fabric filtration for PGD (Flue Gas Desulfurization)  
[PB-289921/9] 22 p0373 N79-21661  
TRW, INC., REDONDO BEACH, CALIF.  
Environmental assessment data base for high-Btu gasification technology. Volume 1: Technical discussion  
[PB-288602/6] 22 p0350 N79-18487  
Environmental assessment data base for high-Btr gasification technology. Volume 2: Appendices A, B, and C  
[PB-288603/4] 22 p0350 N79-18488  
Environmental assessment data base for high-Btu gasification technology. Volume 3: Appendices D, E, and F  
[PB-288604/2] 22 p0350 N79-18489  
Solar cell module assembly jig  
[NASA-CASE-XGS-00829-1] 22 p0353 N79-19447  
TRW SYSTEMS, REDONDO BEACH, CALIF.  
Applicability of petroleum refinery control technologies to coal conversion  
[PB-288630/7] 22 p0352 N79-19173

## U

ULTRASYSTEMS, INC., MCLEAN, VA.  
End use energy consumption data base: Series 1 tables  
[PB-281817/7] 21 p0177 N79-10560  
UNIFIED INDUSTRIES, INC., ALEXANDRIA, VA.  
Army energy plan  
[AD-A057987] 21 p0197 N79-12562  
UNION CARBIDE CORP., TORAWANDA, N.Y.  
Study of hydrogen recovery systems for gas vented while refueling liquid-hydrogen fueled aircraft  
[NASA-CR-158991] 22 p0346 N79-18057  
UNITED ENGINEERS AND CONSTRUCTORS, INC., PHILADELPHIA, PA.  
Cooling systems addendum: Capital and total generating cost studies  
[PB-287306/5] 21 p0231 N79-15431  
UNITED TECHNOLOGIES CORP., EAST HARTFORD, CONN.  
Development of advanced fuel cell system  
[NASA-CR-159443] 21 p0196 N79-12553  
UNITED TECHNOLOGIES CORP., SOUTH WINDSOR, CONN.  
Venture analysis case study for on-site fuel cell energy systems  
[PCR-0783-VOL-1] 22 p0361 N79-20505  
UNITED TECHNOLOGIES CORP., WINDSOR LOCKS, CONN.  
Design, fabrication, and test of a composite material wind turbine rotor blade  
[NASA-CR-135389] 21 p0173 N79-10525  
UNIVERSITY OF EASTERN NEW MEXICO, PORTALES.  
Methane production from carbon oxides over borohydride-reduced transition metals  
[PB-286385/0] 21 p0226 N79-15177  
UNIVERSITY OF SOUTHERN CALIFORNIA, LOS ANGELES.  
Cooking with offshore oil: A handbook for California local government  
[PB-288656/2] 22 p0331 N79-16140  
UOP, INC., DES PLAINES, ILL.  
Optimization of PtDoped KOCITE (trade name) electrodes in H3PO4 fuel cells  
[AD-A061242] 22 p0342 N79-17340  
UTAH STATE UNIV., LOGAN.  
Local perceptions of energy development: The case of the Kaiparowits Plateau  
[PB-287314/9] 22 p0335 N79-16380  
UTAH WATER RESEARCH LAB., LOGAN.  
The impact of energy resource development on water resource allocations  
[PB-286135/9] 21 p0231 N79-15432

## V

VANDERBILT UNIV., NASHVILLE, TENN.  
Investigation of a staged plasma-focus apparatus  
22 p0255 A79-22365  
VARIAN ASSOCIATES, LEXINGTON, MASS.  
Slicing of silicon into sheet material: Silicon sheet growth development for the large area silicon sheet task of the Low Cost Silicon Solar Array project  
[NASA-CR-158082] 22 p0333 N79-16365

**VARIAN ASSOCIATES, PALO ALTO, CALIF.**

- High performance GaAs photovoltaic cells for concentrator applications  
[SAND-78-7018] 21 p0187 N79-11521
- VERSAR, INC., SPRINGFIELD, VA.**  
Assessment of coal cleaning technology  
[PB-287091/3] 22 p0330 N79-16139  
Assessment of coal cleaning technology: An evaluation of chemical coal cleaning processes  
[PB-289493/9] 22 p0372 N79-21625
- VIRGINIA POLYTECHNIC INST. AND STATE UNIV., BLACKSBURG.**  
Analytical methods for evaluating two-dimensional effects in flat-plate solar collectors  
21 p0181 N79-11462
- Evaluation and targeting of geothermal energy resources in the southeastern United States  
[VPI-SU-5648-1] 21 p0204 N79-13478
- VON KARMAN INST. FOR FLUID DYNAMICS, RHODE-SAINT-GENESE (BELGIUM).**  
Closed cycle gas turbines, volume 1  
[VKI-LS-100-VOL-1] 22 p0331 N79-16260

**W**

- WAHLER (W. A.) AND ASSOCIATES, PALO ALTO, CALIF.**  
Pollution control guidelines for coal refuse piles and slurry ponds  
[PB-291369/7] 22 p0373 N79-21682
- WASHINGTON UNIV., SEATTLE.**  
Absorption of solar radiation by alkali vapors  
21 p0108 A79-16612
- A high temperature Rankine binary cycle for ground and space solar engine applications  
21 p0108 A79-16613
- MHD conversion of solar energy**  
21 p0109 A79-16614
- Laser aircraft propulsion**  
21 p0109 A79-16618
- A new concept for solar pumped lasers**  
21 p0110 A79-16624
- Laser aircraft**  
22 p0284 A79-26597
- Blackbody optical pumping of carbon dioxide laser mixtures**  
21 p0203 N79-13343
- A methodology for evaluating the potential materials and energy recovery from municipal solid waste**  
21 p0215 N79-13935
- WASHINGTON UNIV., ST. LOUIS, MO.**  
The ground water and energy supply situation for Great Plains Irrigation  
[PB-286002/1] 21 p0222 N79-14586
- WATER PURIFICATION ASSOCIATES, CAMBRIDGE, MASS.**  
Water-related environmental effects in fuel conversion, volume 1. Summary  
[PB-288313/0] 22 p0351 N79-18834  
Water-related environmental effects in fuel conversion. Volume 2: Appendices  
[PB-288874/1] 22 p0356 N79-19496
- WATERLOO UNIV. (ONTARIO).**  
Methods for reducing heat losses from flat plate solar collectors, phase 2  
[COO-2597-4] 21 p0188 N79-11533
- WEST VIRGINIA UNIV., MORGANTOWN.**  
Design, instrumentation, and calibration of a vertical axis wind turbine rotor  
[TID-27754] 21 p0174 N79-10533  
Thermoelastic solutions for in-situ gasification of coal  
22 p0330 N79-16135
- Simulation of fluidized bed coal combustors  
[NASA-CR-159529] 22 p0359 N79-20487
- WESTINGHOUSE ELECTRIC CORP., PITTSBURGH, PA.**  
Four ignition TNS Tokamak reactor systems: Design summary  
[ORNL/SUB-7117/25] 21 p0193 N79-11889  
Methane utilization from coalbeds for power generation  
[TID-28408] 22 p0352 N79-19171  
Development, testing and evaluation of MHD materials and component designs  
[PB-2248-19] 22 p0369 N79-21558

**WESTINGHOUSE ELECTRIC CORP., TAMPA, FLA.**

- Design and cost study of a nickel-iron oxide battery for electric vehicles. Volume 2: Public report  
[ANL-K-3723-VOL-1] 21 p0222 N79-14579
- WESTINGHOUSE RESEARCH AND DEVELOPMENT CENTER, PITTSBURGH, PA.**  
Silicon web process development  
[NASA-CR-158376] 22 p0357 N79-20282  
Phase two of the array automated assembly task for the low cost solar array project  
[NASA-CR-158359] 22 p0359 N79-20484  
Thin film battery/fuel cell power generating system  
[CONS/1197-9] 22 p0369 N79-21556
- WICHITA STATE UNIV., KANS.**  
Velocity, temperature, and electrical conductivity profiles in hydrogen-oxygen MHD duct flows  
22 p0279 A79-26184
- WILLISTON, MCNEIL AND ASSOCIATES, LAKEWOOD, COLO.**  
A time domain survey of the Los Alamos Region, New Mexico  
[LA-7657-HS] 22 p0365 N79-21248
- WOODWARD-CLYDE CONSULTANTS, SAN FRANCISCO, CALIF.**  
Impact prediction manual for geothermal development  
[PB-288128/2] 22 p0349 N79-18462
- WORLD METEOROLOGICAL ORGANIZATION, GENEVA (SWITZERLAND).**  
Radiation regime of inclined surfaces  
[WHO-467] 21 p0192 N79-11613
- WYLE LABS., INC., HUNTSVILLE, ALA.**  
Indoor test for thermal performance evaluation on the Northrup concentrating solar collector  
[NASA-CR-150804] 21 p0172 N79-10515  
Thermal performance evaluation of the Calmac (liquid) solar collector  
21 p0173 N79-10521  
Large hot water system long range thermal performance test report, addendum  
[NASA-CR-150842] 21 p0204 N79-13492  
Long-term weathering effects on the thermal performance of the Lennox/Honeywell (liquid) solar collector  
[NASA-CR-150818] 21 p0204 N79-13493  
Libbey-Owens-Ford solar collector static load test  
[NASA-CR-150852] 21 p0205 N79-13494  
LARGO hot water system thermal performance test report  
[NASA-CR-150841] 21 p0205 N79-13500  
Thermal performance evaluation of the Solargenics solar collector at outdoor conditions  
[NASA-CR-150857] 21 p0228 N79-15401  
Long term weathering effects on the thermal performance of the sunworks (liquid) solar collector  
[NASA-CR-150899] 22 p0341 N79-17328  
Thermal performance evaluation of MSFC hot air collectors with various flow channel depth  
[NASA-CR-150900] 22 p0348 N79-18449  
Long-term weathering effects on the thermal performance of the Libbey-Owens-Ford (liquid) solar collector  
[NASA-CR-161093] 22 p0348 N79-18450  
Long term weathering effects on the thermal performance of the solaron (air) solar collector  
[NASA-CR-161166] 22 p0371 N79-21621
- WYOMING UNIV., LARAMIE.**  
Kinetic modeling of pyrolysis and hydrogasification of carbonaceous materials  
21 p0179 N79-11150

**Z**

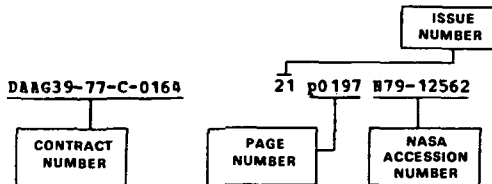
- ZENTRALSTELLE FÜR GEO-PHOTOGRAMMETRIE UND FERNERKUNDUNG, MUNICH (WEST GERMANY).**  
Application of LANDSAT data and digital image processing  
[E79-10102] 22 p0339 N79-17291

# CONTRACT NUMBER INDEX

ENERGY / A Continuing Bibliography (Issue 22)

JULY 1979

## Typical Contract Number Index Listing



Listings in this index are arranged alphanumerically by contract number. Under each contract number, the accession numbers denoting documents that have been produced as a result of research done under that contract are arranged in ascending order with the IAA accession numbers appearing first. The accession number denotes the number by which the citation is identified in either the IAA or STAR section. Preceding the accession number are the issue and page number in the particular supplement in which the citation may be found.

AF PROJ. 2301  
21 p0196 N79-12559  
AF PROJ. 2303  
21 p0230 N79-15415  
AF PROJ. 2307  
22 p0352 N79-19305  
AF PROJ. 2421  
21 p0226 N79-15203  
AF PROJ. 3048  
21 p0216 N79-14231  
AF PROJ. 3145  
21 p0216 N79-14239  
22 p0342 N79-17341  
AF-AFOSR-74-2604  
21 p0052 A79-12986  
AF-AFOSR-3117-77  
21 p0196 N79-12559  
AF-AFOSR-3384-77  
21 p0215 N79-14184  
AID/CSD-2584  
21 p0171 N79-10240  
ANL-31-109-38-3723  
21 p0222 N79-14579  
ARPA ORDER 2552  
22 p0250 A79-21704  
ARPA ORDER 3520  
21 p0193 N79-11859  
AT(04-3)-959  
21 p0026 A79-10222  
21 p0026 A79-10223  
AT(29-1)-789  
21 p0037 A79-11780  
21 p0037 A79-11793  
22 p0280 A79-26202  
AT(45-1)-1830  
21 p0042 A79-11878  
AT(49-24)-0351  
21 p0231 N79-15431  
BNFT-ET-45  
21 p0123 A79-17345  
BNFT-ET-4045-A  
21 p0124 A79-17351  
21 p0128 A79-17391  
21 p0128 A79-17394  
BNFT-ET-4060-A  
21 p0120 A79-17319  
21 p0121 A79-17325  
BNFT-ET-4085-A  
22 p0268 A79-24323  
BPA-EN-78-C-80-1310  
22 p0244 A79-21334  
CSA-00757-G-77-01  
21 p0230 N79-15428  
DA PROJ. 167-62708-AH-67  
22 p0342 N79-17340

DA PROJ. 1L1-61102-AH-51  
21 p0184 N79-11483  
21 p0206 N79-13503  
DA PROJ. 1S7-62705-AH-94  
21 p0206 N79-13504  
DA PROJ. 3E7-62720-A-835  
21 p0192 N79-11686  
21 p0193 N79-11688  
DA PROJ. 4A7-62731-AT-41  
22 p0363 N79-20522  
DAAE07-76-C-0063  
21 p0052 A79-12982  
DAAG39-77-C-0164  
21 p0197 N79-12562  
DAAG53-75-C-0278  
21 p0230 N79-15413  
DAAG53-76-C-0003  
21 p0171 N79-10216  
22 p0357 N79-20279  
DAAG53-76-C-0014  
22 p0342 N79-17340  
DAAG56-76-C-0003  
21 p0216 N79-14232  
DAAK70-77-C-0047  
21 p0184 N79-11483  
DAAK70-77-C-0080  
21 p0206 N79-13503  
DAAK70-77-C-0128  
21 p0206 N79-13505  
DAAK70-78-C-0001  
22 p0274 A79-25899  
21 p0171 N79-10216  
21 p0216 N79-14232  
22 p0357 N79-20279  
DAMD17-77-C-7020  
21 p0192 N79-11686  
21 p0193 N79-11688  
DE-A101-79ET20485  
22 p0354 N79-19451  
DEB-3-12  
21 p0205 N79-13496  
DEB-3-38  
22 p0368 N79-21554  
DEB-3-40  
22 p0354 N79-19451  
DEB-3-00019  
22 p0364 N79-21075  
DFG-A1-104/6  
21 p0007 A79-10063  
DI-14-16-0008-2132  
22 p0349 N79-18462  
DI-14-16-0008-2152  
21 p0199 N79-12576  
DI-18-16-0009-77-004  
22 p0340 N79-17311

DI-14-31-0001-7030  
22 p0349 N79-18463  
DI-14-32-0001-1213  
21 p0081 A79-14935  
DI-14-34-0001-6125  
21 p0231 N79-15432  
DI-14-34-0001-7080  
22 p0343 N79-17353  
DOE-CO-03-50346-00  
21 p0177 N79-10560  
DOE-CO-03-60410  
21 p0177 N79-10560  
DOE-CO-03-60412-00  
21 p0177 N79-10560  
DOE-EA-77-A-01-6010  
22 p0343 N79-17350  
DOE-EA-77-01-6010  
21 p0198 N79-12571  
DOE-EX-76-C-01-2445  
22 p0351 N79-18834  
DOE-G-77-A-01-4070  
21 p0229 N79-15406  
DOE-PF-67025-F  
22 p0278 A79-26177  
DOE-OS-4564A  
21 p0021 A79-10172  
DOE-76-C-03-1229  
21 p0012 A79-10105  
DOE-77-G-01-1663  
21 p0229 N79-15405  
DOT-OS-60152  
21 p0159 A79-19766  
DOT-OS-60519  
21 p0181 N79-11446  
21 p0181 N79-11447  
DOT-TSC-920  
22 p0366 N79-21406  
DOT-TSC-1349-1  
22 p0370 N79-21563  
DOT-UT-60096T  
21 p0177 N79-10563  
DOT-UT-60097T  
21 p0176 N79-10555  
21 p0176 N79-10556  
21 p0177 N79-10557  
21 p0177 N79-10558  
21 p0177 N79-10559  
DOT/TSC-BA-75-10  
21 p0227 N79-15311  
21 p0227 N79-15312  
21 p0227 N79-15313  
21 p0228 N79-15314  
21 p0228 N79-15315  
DOT/TSC-BA-76-23  
21 p0227 N79-15308  
21 p0227 N79-15309  
21 p0227 N79-15310  
DSS-OSU77-00099  
22 p0320 A79-31432  
DSS-12SQ-31155-7-4409  
22 p0316 A79-31403  
22 p0317 A79-31413  
DSS-12SQ-31155-7-4410  
22 p0317 A79-31409  
E(04-3)-3-PA-215  
22 p0252 A79-22237  
E(04-3)-34-PA-215  
22 p0253 A79-22244  
E(04-3)-34-PA-236  
22 p0249 A79-21688  
E(04-3)-167  
21 p0027 A79-10224  
22 p0331 N79-16261  
E(04-3)-1109  
22 p0288 A79-27399  
E(04-3)-1110  
21 p0162 A79-19832  
E(04-3)-1203  
22 p0281 A79-26242  
E(04-3)-1241  
21 p0171 N79-10237

E(04-3)-1283  
22 p0272 A79-25069  
E(04-3)-1286  
22 p0308 A79-30543  
E(04-03)-1256  
21 p0042 A79-11877  
E(11-1)-2588  
21 p0066 A79-14262  
21 p0149 A79-18018  
21 p0149 A79-18020  
22 p0295 A79-28359  
E(11-1)-2616  
22 p0238 A79-20798  
E(11-1)-2868  
21 p0088 A79-15836  
E(11-1)-2941  
22 p0281 A79-26206  
E(11-1)-3073  
21 p0077 A79-14778  
E(40-1)-4952  
21 p0038 A79-11806  
E(40-1)-4976  
21 p0138 A79-17474  
E(40-1)-5100  
21 p0149 A79-18019  
E(40-1)-5136  
22 p0281 A79-26208  
E(40-1)-5190  
22 p0281 A79-26210  
E(49-1)-3800  
22 p0355 N79-19467  
E(49-18)-1220  
21 p0045 A79-12121  
E(49-18)-1536  
21 p0080 A79-14932  
E(49-18)-1742  
21 p0220 N79-14564  
21 p0221 N79-14575  
E(49-18)-1811  
21 p0046 A79-12274  
E(49-18)-2212  
21 p0083 A79-15247  
E(49-18)-2217  
22 p0235 A79-20534  
E(49-18)-2268  
21 p0068 A79-14321  
E(49-18)-2321  
21 p0216 N79-14240  
E(49-18)-2358  
22 p0278 A79-26180  
E(49-18)-2369  
21 p0029 A79-10246  
E(49-18)-2385  
21 p0172 N79-10518  
E(49-18)-2426  
21 p0141 A79-17505  
E(49-18)-2484  
22 p0288 A79-27395  
E(49-18)-2538  
21 p0042 A79-11966  
22 p0300 A79-29428  
E(49-26)-1004  
22 p0333 N79-16357  
22 p0360 N79-20494  
E(49-26)-1022  
22 p0342 N79-17336  
E(49-26)-1028  
22 p0244 A79-21302  
21 p0173 N79-10525  
21 p0195 N79-12548  
22 p0333 N79-16355  
22 p0341 N79-17333  
22 p0360 N79-20497  
22 p0368 N79-21549  
E(49-28)-1002  
21 p0040 A79-11824  
21 p0183 N79-11479  
EA-77-A-01-6010  
21 p0190 N79-11543  
22 p0357 N79-20291  
22 p0363 N79-20524  
22 p0365 N79-21235

# CONTRACT NUMBER INDEX

EC-17-S-02-4272  
 21 p0052 A79-12986  
 EC-77-A-31-1011  
 21 p0009 A79-10084  
 22 p0345 A79-17859  
 EC-77-A-31-1034  
 22 p0243 A79-21300  
 21 p0183 A79-11473  
 21 p0183 A79-11481  
 21 p0205 A79-13496  
 22 p0354 A79-19454  
 22 p0360 A79-20498  
 22 p0368 A79-21550  
 22 p0368 A79-21554  
 EC-77-A-31-1040  
 21 p0035 A79-11542  
 21 p0081 A79-14956  
 22 p0337 A79-16721  
 EC-77-C-01-5017  
 21 p0210 A79-13536  
 EC-77-C-01-5025  
 21 p0220 A79-14565  
 EC-77-C-01-5081  
 21 p0183 A79-11473  
 EC-77-C-02-4396  
 22 p0315 A79-31369  
 21 p0181 A79-11406  
 EC-77-C-02-4434  
 21 p0015 A79-10128  
 EC-77-C-03-1404  
 21 p0010 A79-10091  
 EC-77-C-03-1574  
 21 p0012 A79-10100  
 EC-77-C-05-5392  
 21 p0025 A79-10211  
 EC-77-X-01-2923  
 21 p0201 A79-13190  
 EC-77-X-01-3559  
 21 p0046 A79-12265  
 EC-77-X-01-4111  
 21 p0045 A79-12264  
 EC-78-C-03-1737  
 21 p0201 A79-13189  
 EDA-PF-612  
 21 p0177 A79-10564  
 EDA-99-7-13426  
 21 p0177 A79-10564  
 EDA-77-C-02-4310  
 21 p0198 A79-12575  
 EDA-77-C-02-4389  
 21 p0213 A79-13569  
 EDA-77-C-03-1364  
 21 p0195 A79-12256  
 EF-75-C-01-2256  
 21 p0157 A79-19589  
 EF-76-C-01-2215  
 22 p0362 A79-20511  
 EF-76-C-01-2256  
 21 p0009 A79-10079  
 EF-77-A-01-2647  
 22 p0279 A79-26184  
 EF-77-A-01-2674  
 21 p0183 A79-11478  
 22 p0341 A79-17335  
 EF-77-C-01-2524  
 21 p0016 A79-10135  
 21 p0161 A79-19809  
 22 p0363 A79-20517  
 EF-77-C-01-2583  
 21 p0203 A79-13280  
 EF-77-C-01-2613  
 22 p0362 A79-20515  
 22 p0363 A79-20516  
 EF-77-C-01-2614  
 22 p0369 A79-21560  
 22 p0369 A79-21561  
 EF-77-C-01-2664  
 21 p0180 A79-11223  
 EF-77-G-01-6003  
 21 p0171 A79-10243  
 EF-77-S-02-4227  
 21 p0170 A79-10178  
 EG-77-A-03-1509  
 21 p0162 A79-19834  
 EG-77-C-01-4024  
 22 p0243 A79-21259  
 22 p0337 A79-16895  
 EG-77-C-01-4028  
 21 p0209 A79-13533  
 EG-77-C-02-4181  
 21 p0193 A79-11890

EG-77-C-03-1326  
 21 p0174 A79-10532  
 EG-77-C-03-1569  
 21 p0101 A79-16249  
 EG-77-C-03-1587  
 21 p0211 A79-13544  
 EG-77-C-04-3974  
 22 p0281 A79-26207  
 EG-77-C-04-3985  
 21 p0019 A79-10159  
 21 p0062 A79-13873  
 EG-77-C-04-3988  
 21 p0019 A79-10160  
 EG-77-C-05-5359  
 21 p0101 A79-16251  
 EG-77-C-05-5560  
 21 p0016 A79-10133  
 EG-77-C-06-1033  
 22 p0287 A79-27377  
 EG-77-G-04-4087  
 21 p0021 A79-10174  
 EG-77-G-04-4138  
 21 p0022 A79-10180  
 EG-77-S-01-4116  
 21 p0154 A79-18487  
 22 p0281 A79-26243  
 EG-77-S-02-4183  
 22 p0292 A79-27885  
 EG-77-S-02-4238  
 21 p0161 A79-19815  
 EG-77-S-02-4479  
 22 p0267 A79-24314  
 EG-77-S-04-4094  
 21 p0087 A79-15826  
 EG-77-S-52-4450  
 22 p0273 A79-25720  
 EH-75-C-01-8516  
 21 p0184 A79-11489  
 EH-77-C-01-8727  
 21 p0207 A79-13512  
 EH-78-C-04-4275  
 21 p0062 A79-13872  
 22 p0293 A79-28145  
 EPA TASK 5  
 22 p0296 A79-28389  
 EPA TASK 6  
 22 p0296 A79-28389  
 EPA TASK 7  
 22 p0296 A79-28389  
 EPA-TAG-D6-B695  
 22 p0340 A79-17311  
 EPA-R-803242  
 21 p0232 A79-15474  
 EPA-R-803971  
 21 p0082 A79-15032  
 EPA-R-804183  
 22 p0372 A79-21626  
 EPA-R-804979  
 22 p0339 A79-17027  
 EPA-R-805052  
 22 p0336 A79-16437  
 EPA-R-805374  
 22 p0344 A79-17378  
 EPA-R-805615-01  
 21 p0198 A79-12575  
 EPA-R-803903010  
 21 p0082 A79-15115  
 21 p0158 A79-19735  
 EPA-R-803971020  
 21 p0082 A79-15052  
 EPA-68-01-2940  
 21 p0178 A79-10574  
 EPA-68-01-3539  
 21 p0213 A79-13592  
 EPA-68-01-4337  
 21 p0211 A79-13548  
 EPA-68-02-0227  
 21 p0158 A79-19738  
 EPA-68-02-0293  
 21 p0232 A79-15864  
 22 p0339 A79-17026  
 EPA-68-02-1320  
 21 p0223 A79-14643  
 EPA-68-02-1323  
 22 p0365 A79-21224  
 EPA-68-02-1361  
 21 p0080 A79-14927  
 21 p0178 A79-10610  
 EPA-68-02-1415  
 21 p0158 A79-19738

EPA-68-02-1438  
 22 p0296 A79-28389  
 EPA-68-02-1480  
 21 p0199 A79-12601  
 EPA-68-02-1816  
 21 p0178 A79-10603  
 EPA-68-02-1863  
 22 p0346 A79-18061  
 EPA-68-02-1874  
 21 p0223 A79-14635  
 22 p0353 A79-19429  
 EPA-68-02-2093  
 21 p0200 A79-12602  
 EPA-68-02-2101  
 21 p0224 A79-14946  
 EPA-68-02-2119  
 22 p0338 A79-17025  
 EPA-68-02-2147  
 21 p0232 A79-15479  
 22 p0373 A79-21662  
 EPA-68-02-2153  
 21 p0195 A79-12424  
 EPA-68-02-2155  
 22 p0336 A79-16446  
 EPA-68-02-2156  
 22 p0336 A79-16439  
 EPA-68-02-2162  
 21 p0178 A79-10595  
 22 p0344 A79-17364  
 22 p0344 A79-17365  
 22 p0373 A79-21671  
 EPA-68-02-2165  
 22 p0373 A79-21661  
 EPA-68-02-2172  
 21 p0216 A79-14243  
 EPA-68-02-2196  
 21 p0080 A79-14927  
 EPA-68-02-2199  
 22 p0330 A79-16139  
 22 p0372 A79-21625  
 EPA-68-02-2535  
 21 p0178 A79-10591  
 EPA-68-02-2603  
 21 p0200 A79-12606  
 EPA-68-02-2610  
 21 p0223 A79-14618  
 EPA-68-02-2624  
 21 p0159 A79-19742  
 EPA-68-02-2635  
 22 p0350 A79-18487  
 22 p0350 A79-18488  
 22 p0350 A79-18489  
 22 p0352 A79-19173  
 EPA-68-02-2800  
 22 p0364 A79-20727  
 EPA-68-03-2186  
 21 p0035 A79-11448  
 EPA-68-03-2207  
 22 p0351 A79-18834  
 22 p0356 A79-19496  
 EPA-68-03-2344  
 22 p0373 A79-21682  
 EPA-68-03-2347  
 21 p0179 A79-10968  
 EPA-68-03-2356  
 21 p0231 A79-15440  
 EPA-68-03-2431  
 22 p0373 A79-21682  
 EPA-68-03-2528  
 22 p0295 A79-28182  
 EPA-68-03-2636  
 21 p0228 A79-15379  
 EPA-68-92-2515  
 21 p0223 A79-14641  
 EPRI PROJ. 239  
 21 p0180 A79-11238  
 ER-78-S-02-4899  
 22 p0294 A79-28148  
 22 p0294 A79-28149  
 22 p0294 A79-28152  
 ERDA PROJECT 38  
 21 p0085 A79-15318  
 ERDA PROJECT 60  
 21 p0027 A79-10224  
 ERDA TASK 23  
 22 p0278 A79-26179  
 ERDA 31-109-38-3628  
 22 p0314 A79-31363  
 ERDA 31-109-38-4206  
 22 p0314 A79-31363

ES-77-C-02-4149  
 21 p0085 A79-15334  
 21 p0085 A79-15335  
 ESA-3404/77-P-HEW(SC)  
 22 p0335 A79-16379  
 ET-76-S-02-2272  
 22 p0253 A79-22242  
 ET-76-01-9036  
 21 p0204 A79-13474  
 ET-78-C-01-2706  
 22 p0362 A79-20510  
 ET-78-C-01-2712  
 21 p0158 A79-19654  
 ET-78-C-01-3005  
 21 p0017 A79-10141  
 ET-78-C-01-3019  
 22 p0313 A79-31188  
 ET-78-C-01-3087  
 22 p0363 A79-20518  
 ET-78-C-05-5648  
 21 p0204 A79-13478  
 EUKATOM-30-74-IFUA-C  
 21 p0079 A79-14792  
 EX-76-A-29-1060  
 21 p0012 A79-10103  
 21 p0019 A79-10161  
 21 p0021 A79-10173  
 EX-76-A-31-1011  
 21 p0215 A79-13937  
 EX-76-C-01-1534  
 21 p0180 A79-11166  
 EX-76-C-01-1760  
 21 p0016 A79-10134  
 21 p0017 A79-10139  
 21 p0017 A79-10142  
 21 p0081 A79-14935  
 22 p0279 A79-26186  
 EX-76-C-01-2025  
 21 p0192 A79-11607  
 EX-76-C-01-2044  
 21 p0006 A79-10055  
 EX-76-C-01-2121  
 21 p0210 A79-13540  
 EX-76-C-01-2206  
 21 p0180 A79-11239  
 EX-76-C-01-2246  
 21 p0017 A79-10138  
 21 p0161 A79-19810  
 EX-76-C-01-2247  
 21 p0006 A79-10059  
 EX-76-C-01-2248  
 22 p0369 A79-21558  
 EX-76-C-01-2336  
 21 p0009 A79-10077  
 EX-76-C-01-2341  
 22 p0362 A79-20512  
 22 p0365 A79-21310  
 EX-76-C-01-2371  
 21 p0008 A79-10068  
 EX-76-C-01-2426  
 21 p0174 A79-10535  
 EX-76-C-01-2528  
 21 p0209 A79-13534  
 EX-76-C-01-3077  
 21 p0023 A79-10188  
 EX-76-C-04-0789  
 21 p0209 A79-13532  
 EX-76-C-16-3869  
 21 p0206 A79-13508  
 EX-76-C-16-3084  
 21 p0025 A79-10210  
 EX-76-S-01-2334  
 21 p0171 A79-10238  
 EX-77-C-01-2518  
 21 p0006 A79-10055  
 EX-77-C-01-2639  
 21 p0068 A79-14400  
 EX-77-C-01-2684  
 22 p0361 A79-20505  
 EX-77-S-04-3709  
 22 p0294 A79-28152  
 EX-76-C-2-2616  
 21 p0029 A79-10238  
 22 p0279 A79-26182  
 EX-76-C-01-2322  
 21 p0174 A79-10538  
 EX-76-C-02-0016  
 21 p0013 A79-10111  
 22 p0250 A79-21699  
 22 p0251 A79-21715  
 21 p0185 A79-11499

# CONTRACT NUMBER INDEX

21 p0185 879-11500  
 21 p0188 879-11528  
 21 p0192 879-11641  
 21 p0208 879-13524  
 21 p0208 879-13525  
 21 p0209 879-13526  
 21 p0210 879-13538  
 21 p0213 879-13572  
 22 p0361 879-20502  
 22 p0364 879-20927  
 22 p0370 879-21564  
 EY-76-C-02-0578-034  
 22 p0239 879-20823  
 EY-76-C-02-2331  
 21 p0026 879-10221  
 EY-76-C-02-2477  
 21 p0231 879-15431  
 EY-76-C-02-2520  
 21 p0041 879-11838  
 21 p0305 879-30332  
 EY-76-C-02-2617  
 21 p0204 879-13378  
 EY-76-C-02-2709  
 21 p0085 879-15334  
 21 p0085 879-15335  
 EY-76-C-02-2802  
 21 p0048 879-12569  
 EY-76-C-02-2835  
 22 p0351 879-18817  
 EY-76-C-02-2949  
 21 p0011 879-10094  
 EY-76-C-02-3056  
 21 p0026 879-10215  
 EY-76-C-02-3073  
 21 p0111 879-16727  
 21 p0155 879-18830  
 22 p0237 879-20557  
 22 p0255 879-22379  
 22 p0292 879-27884  
 EY-76-C-02-4055  
 21 p0187 879-11512  
 EY-76-C-03-0167  
 21 p0015 879-10127  
 21 p0085 879-15318  
 22 p0253 879-22240  
 22 p0290 879-27667  
 EY-76-C-03-0167-038  
 21 p0214 879-13871  
 21 p0214 879-13872  
 EY-76-C-03-1018  
 22 p0313 879-31185  
 EY-76-C-03-1101  
 21 p0061 879-13866  
 EY-76-C-03-1109  
 21 p0210 879-13542  
 EY-76-C-03-1165  
 21 p0010 879-10092  
 EY-76-C-03-1197  
 22 p0369 879-21556  
 EY-76-C-03-1213  
 21 p0092 879-15885  
 EY-76-C-03-1228  
 22 p0365 879-21309  
 EY-76-C-03-1260  
 21 p0207 879-13514  
 21 p0207 879-13515  
 EY-76-C-03-1285  
 22 p0273 879-25744  
 EY-76-C-03-1335  
 21 p0195 879-12450  
 EY-76-C-04-0053  
 22 p0248 879-21684  
 EY-76-C-04-0789  
 21 p0172 879-10435  
 21 p0175 879-10539  
 21 p0185 879-11493  
 21 p0185 879-11496  
 21 p0187 879-11516  
 21 p0187 879-11517  
 21 p0187 879-11521  
 21 p0187 879-11525  
 21 p0187 879-11526  
 21 p0188 879-11527  
 21 p0188 879-11529  
 21 p0189 879-11537  
 21 p0197 879-12565  
 21 p0198 879-12570  
 21 p0206 879-13509  
 21 p0208 879-13522  
 21 p0210 879-13537

EY-76-C-04-3684  
 21 p0194 879-12249  
 21 p0201 879-13191  
 EY-76-C-05-0033  
 21 p0209 879-13531  
 EY-76-C-05-0333  
 21 p0174 879-10534  
 EY-76-C-05-5135  
 21 p0174 879-10533  
 EY-76-C-06-1830  
 21 p0068 879-14294  
 21 p0095 879-15913  
 22 p0241 879-21056  
 22 p0294 879-28153  
 21 p0170 879-10179  
 21 p0202 879-13252  
 21 p0203 879-13322  
 21 p0209 879-13527  
 21 p0210 879-13539  
 21 p0210 879-13541  
 21 p0217 879-14344  
 22 p0356 879-19568  
 22 p0361 879-20504  
 22 p0361 879-20506  
 22 p0369 879-21557  
 EY-76-C-07-1540  
 22 p0369 879-21559  
 EY-76-C-07-1570  
 22 p0362 879-20508  
 EY-76-C-02-2597  
 21 p0188 879-11533  
 EY-76-S-01-2554  
 21 p0157 879-19541  
 EY-76-S-02-2577  
 21 p0206 879-13507  
 21 p0209 879-13530  
 EY-76-S-02-2711  
 22 p0292 879-27887  
 22 p0313 879-31188  
 EY-76-S-02-2908  
 22 p0358 879-20459  
 EY-76-S-02-2982  
 21 p0063 879-13876  
 EY-76-S-02-3237  
 22 p0313 879-31189  
 EY-76-S-02-4009  
 21 p0120 879-17314  
 EY-76-S-02-4051  
 21 p0014 879-10118  
 21 p0096 879-15920  
 21 p0159 879-19776  
 EY-76-S-04-3709  
 22 p0294 879-28148  
 EY-76-S-05-4241  
 21 p0128 879-17390  
 EY-76-S-05-4908  
 22 p0363 879-20525  
 22 p0372 879-21631  
 EY-76-S-05-4976-A003  
 21 p0164 879-19848  
 22 p0264 879-23781  
 EY-76-S-05-5216  
 21 p0201 879-13189  
 EY-76-S-06-2227  
 21 p0031 879-10278  
 22 p0278 879-26179  
 EY-76-S-06-2342  
 22 p0287 879-27345  
 EY-76-S-06-2429  
 21 p0150 879-18092  
 EY-76-S-06-2439  
 21 p0068 879-14295  
 22 p0299 879-29371  
 EY-76-S-02-2641  
 21 p0142 879-17506  
 EY-76-S-02-4051-A001  
 22 p0266 879-24239  
 EY-77-C-01-1514  
 21 p0145 879-17633  
 EY-77-C-05-4478  
 22 p0269 879-24813  
 EY-77-C-07-1622  
 21 p0208 879-13523  
 EY-77-C-08-1531  
 22 p0366 879-21523  
 EY-77-C-21-8098  
 22 p0352 879-19171  
 EY-77-S-02-2446  
 21 p0134 879-17439  
 21 p0134 879-17440

FAA PROJ. 081-431-100  
 21 p0196 879-12555  
 EY-76-C-01-2292  
 21 p0032 879-10778  
 P08635-76-C-0276  
 21 p0206 879-13506  
 P19628-78-C-0002  
 21 p0226 879-15145  
 P33615-75-C-2004  
 21 p0220 879-14561  
 P33615-75-C-2043  
 21 p0216 879-14239  
 P33615-76-C-2001  
 21 p0230 879-15414  
 P33615-76-C-2171  
 22 p0342 879-17341  
 P33615-76-C-3104  
 22 p0351 879-18969  
 22 p0356 879-20109  
 P33615-76-C-5034  
 21 p0226 879-15203  
 P33617-75-90100  
 21 p0065 879-14122  
 P42600-76-C-1214  
 21 p0011 879-10095  
 P44620-75-C-0037  
 22 p0292 879-27884  
 P49620-77-C-0138  
 22 p0294 879-28152  
 GEN. ATOMIC PROJ. 2095  
 22 p0331 879-16261  
 GEN. ATOMIC PROJ. 3227  
 22 p0331 879-16261  
 GEN. ATOMIC PROJ. 4351  
 22 p0331 879-16261  
 HUD-B-40-72  
 21 p0220 879-14564  
 HUD-B-2689  
 22 p0331 879-16148  
 22 p0331 879-16150  
 22 p0336 879-16497  
 22 p0355 879-19468  
 JPL-954343  
 21 p0219 879-14541  
 JPL-954352  
 22 p0308 879-30543  
 22 p0348 879-18445  
 JPL-954355  
 22 p0359 879-20483  
 JPL-954363  
 22 p0348 879-18451  
 JPL-954373  
 21 p0219 879-14540  
 JPL-954374  
 22 p0333 879-16365  
 JPL-954393  
 21 p0219 879-14551  
 JPL-954471  
 21 p0218 879-14537  
 JPL-954527  
 21 p0195 879-12544  
 JPL-954654  
 22 p0357 879-20282  
 JPL-954796  
 22 p0335 879-16378  
 JPL-954833  
 22 p0367 879-21545  
 JPL-954862  
 21 p0219 879-14555  
 JPL-954868  
 22 p0358 879-20480  
 JPL-954873  
 22 p0359 879-20484  
 JPL-954883  
 21 p0219 879-14548  
 22 p0354 879-19459  
 JPL-954886  
 22 p0357 879-20281  
 JPL-954898  
 22 p0358 879-20481  
 JPL-954899  
 21 p0200 879-12970  
 22 p0333 879-16351  
 JPL-954914  
 22 p0358 879-20482  
 JPL-954971  
 22 p0335 879-16377  
 JPL-955062  
 22 p0334 879-16366  
 JPL-955077  
 22 p0334 879-16368

JPL-955089  
 22 p0359 879-20485  
 JPL-955110  
 21 p0219 879-14546  
 JPL-955121  
 22 p0367 879-21547  
 JPL-955164  
 22 p0359 879-20486  
 NDA903-78-C-0189  
 21 p0193 879-11859  
 NASA ORDER C-7653  
 22 p0360 879-20497  
 NASA ORDER W-14280  
 21 p0109 879-16617  
 NASW-2018  
 22 p0345 879-17898  
 NASW-3048  
 21 p0110 879-16622  
 NASW-3198  
 21 p0183 879-11474  
 NASW-3199  
 21 p0195 879-12547  
 22 p0364 879-21217  
 NAS1-13285  
 21 p0200 879-13026  
 NAS1-14208  
 22 p0363 879-20519  
 NAS1-14698  
 22 p0346 879-18057  
 NAS2-9109  
 21 p0110 879-16629  
 NAS2-9185  
 21 p0111 879-16632  
 NAS3-18517  
 21 p0173 879-10526  
 NAS3-18541  
 21 p0196 879-12554  
 NAS3-19773  
 21 p0173 879-10525  
 NAS3-19778  
 21 p0196 879-12553  
 NAS3-19780  
 22 p0334 879-16374  
 NAS3-19885  
 21 p0084 879-15305  
 NAS3-20058  
 22 p0239 879-20825  
 22 p0240 879-20826  
 22 p0240 879-20827  
 22 p0288 879-27400  
 NAS3-20270  
 21 p0013 879-10113  
 NAS3-20615  
 21 p0012 879-10106  
 21 p0120 879-17321  
 22 p0354 879-19454  
 NAS3-20628  
 21 p0194 879-12084  
 NAS3-20646  
 22 p0337 879-16850  
 NAS3-20802  
 21 p0200 879-13050  
 NAS3-21134  
 21 p0110 879-16624  
 NAS3-21137  
 22 p0366 879-21334  
 22 p0366 879-21335  
 NAS7-100  
 21 p0011 879-10099  
 21 p0020 879-10167  
 21 p0020 879-10169  
 21 p0023 879-10186  
 21 p0023 879-10187  
 21 p0024 879-10203  
 21 p0026 879-10220  
 21 p0026 879-10222  
 21 p0026 879-10223  
 21 p0027 879-10225  
 21 p0042 879-11955  
 21 p0045 879-12119  
 21 p0047 879-12324  
 21 p0062 879-13869  
 21 p0067 879-14269  
 21 p0076 879-14765  
 21 p0076 879-14766  
 21 p0086 879-15504  
 21 p0098 879-16103  
 21 p0103 879-16455  
 21 p0104 879-16466  
 21 p0107 879-16603  
 21 p0107 879-16604

# CONTRACT NUMBER INDEX

21 p0108 A79-16607	NAS8-32251	HRC 042-271	HSP ENG-76-84439
21 p0123 A79-17340	21 p0173 H79-10523	22 p0264 A79-23809	21 p0152 A79-18151
21 p0162 A79-19837	NAS8-32253	HRC 077-9	HSP ENV-74-24276
22 p0239 A79-20821	22 p0341 H79-17331	22 p0320 A79-31434	21 p0113 A79-16745
22 p0244 A79-21347	NAS8-32254	HRC-04-77-065	HSP EPP-75-04148
22 p0252 A79-21807	21 p0172 H79-10517	21 p0223 H79-14934	22 p0260 A79-23609
22 p0259 A79-23604	NAS8-32257	HSC-65E-0401-03(03)	HSP GI-38701
22 p0260 A79-23612	22 p0371 H79-21619	22 p0319 A79-31425	21 p0044 A79-12116
21 p0195 H79-12543	NAS8-32259	HSP AER-72-03478	HSP IBT-76-02664
21 p0195 H79-12544	21 p0229 H79-15404	21 p0042 A79-11966	22 p0294 A79-28150
21 p0200 H79-12970	22 p0333 H79-16360	HSP AER-73-0359-A02	HSP ISP-76-02379
21 p0202 H79-13263	22 p0334 H79-16370	22 p0262 A79-23719	21 p0194 H79-12250
21 p0203 H79-13370	22 p0341 H79-17332	HSP AER-73-03197	HSP MCS-76-23801
21 p0204 H79-13474	NAS8-32260	22 p0272 A79-25084	21 p0154 A79-18472
21 p0205 H79-13501	21 p0229 H79-15402	21 p0198 H79-12572	HSP OCE-76-18049
21 p0218 H79-14537	NAS8-32475	22 p0343 H79-17349	22 p0288 A79-27391
21 p0219 H79-14540	21 p0003 A79-10033	HSP AER-73-03291	HSP SER-76-05002
21 p0219 H79-14546	21 p0183 H79-11475	21 p0199 H79-12577	21 p0031 A79-10257
21 p0219 H79-14548	21 p0225 H79-15137	21 p0230 H79-15422	HSP SMI-76-83578
21 p0219 H79-14551	21 p0225 H79-15138	HSP AER-74-20678	21 p0113 A79-16740
22 p0333 H79-16351	21 p0225 H79-15139	21 p0068 A79-14400	HSG-1022
22 p0333 H79-16365	21 p0225 H79-15140	HSP AER-75-00033	22 p0255 A79-22365
22 p0334 H79-16368	21 p0225 H79-15141	21 p0141 A79-17505	HSG-1235
22 p0348 H79-18451	21 p0225 H79-15142	HSP AER-75-00826	22 p0255 A79-22365
22 p0354 H79-19449	22 p0329 H79-16036	21 p0195 H79-12542	HSG-1390
22 p0354 H79-19450	22 p0330 H79-16037	HSP AER-75-03779	22 p0367 H79-21543
22 p0354 H79-19459	22 p0352 H79-19071	21 p0041 A79-11838	HSG-3134
22 p0358 H79-20480	NAS8-32481	HSP AER-75-08693	22 p0359 H79-20487
22 p0359 H79-20484	21 p0173 H79-10522	22 p0265 A79-24046	HSG-3186
22 p0359 H79-20490	NAS8-32928	HSP AER-75-08793	22 p0279 A79-26184
22 p0359 H79-20491	22 p0345 H79-17890	22 p0256 A79-22756	HSG-3214
22 p0360 H79-20492	NAS8-33002	22 p0335 H79-16385	22 p0288 A79-27395
22 p0362 H79-20513	22 p0368 H79-21551	HSP AER-75-09538	HSG-7331
22 p0366 H79-21390	22 p0368 H79-21552	21 p0052 A79-12986	21 p0215 H79-14192
22 p0367 H79-21547	NAS8-33065	HSP AER-75-09588	H0024-77-C-4366
22 p0368 H79-21548	21 p0215 H79-14143	22 p0367 H79-21530	22 p0307 A79-30533
NAS8-33302	NAS8-33157	HSP AER-75-14536	H00014-75-C-0210
22 p0243 A79-21270	22 p0345 H79-17896	21 p0041 A79-11871	22 p0288 A79-27391
NAS8-27980	NAS9-15196	21 p0042 A79-11875	H00014-75-C-1143
22 p0366 H79-21429	21 p0003 A79-10027	HSP AER-75-20501	22 p0338 H79-17011
NAS8-31293	NAS9-15237	22 p0256 A79-22859	H00014-77-F-0006
22 p0358 H79-20478	21 p0194 H79-12130	HSP AER-75-21364	21 p0197 H79-12564
22 p0360 H79-20499	NAS9-15240	21 p0083 A79-15245	H00014-77-G-0034
NAS8-32026	22 p0337 H79-16892	HSP AER-76-05596	21 p0063 A79-13985
21 p0228 H79-15401	NAS9-15286	21 p0066 A79-14265	H00014-78-C-0097
NAS8-32034	22 p0371 H79-21622	22 p0335 H79-16382	21 p0197 H79-12560
22 p0339 H79-17289	NAS9-15423	HSP AER-76-08210	H00140-77-C-1345
NAS8-32036	21 p0171 H79-10272	22 p0330 H79-16138	22 p0274 A79-25899
21 p0172 H79-10515	NAS9-15453	HSP AER-76-09300	OWRT PROJ. A-048-PA(3)
21 p0173 H79-10521	22 p0330 H79-16039	21 p0044 A79-12116	22 p0343 H79-17353
21 p0204 H79-13492	NAS9-15507	HSP AER-77-11545	OWRT PROJ. A-081-ILL
21 p0204 H79-13493	22 p0330 H79-16057	22 p0343 H79-17354	22 p0349 H79-18463
21 p0205 H79-13494	NAS9-15595	HSP AER-77-17031	OWRT PROJ. B-131-UTAH(1)
21 p0205 H79-13499	21 p0194 H79-12136	21 p0222 H79-14586	21 p0231 H79-15432
21 p0205 H79-13500	NEEC-GR/3/2951	HSP AER-03259-A03	PROJ. SQUID
22 p0333 H79-16359	22 p0272 A79-25375	22 p0282 A79-26462	22 p0338 H79-17011
22 p0333 H79-16361	HGL-05-003-003	HSP AG-502	PROJ. 3235
22 p0341 H79-17328	21 p0031 A79-10419	21 p0090 A79-15858	21 p0214 H79-13872
22 p0348 H79-18448	22 p0272 A79-25375	HSP ATA-76-09581	PROJECT SQUID
22 p0348 H79-18449	HGL-23-004-083	21 p0041 A79-11871	21 p0051 A79-12977
22 p0348 H79-18450	22 p0347 H79-18424	21 p0042 A79-11875	USDA-WA-76-4277
22 p0371 H79-21621	HGL-48-002-044	HSP C-75-22186	21 p0076 A79-14763
NAS8-32091	21 p0110 A79-16624	21 p0142 A79-17512	W-31-109-ENG-38
21 p0196 H79-12552	HGL-49-002-044	HSP C-75-22221-01	21 p0089 A79-15855
NAS8-32092	21 p0108 A79-16612	21 p0189 H79-11535	21 p0157 A79-19588
21 p0172 H79-10516	21 p0108 A79-16613	21 p0207 H79-13510	22 p0279 A79-26183
NAS8-32093	21 p0109 A79-16614	21 p0207 H79-13511	22 p0290 A79-27661
21 p0220 H79-14557	21 p0109 A79-16618	HSP C-310	22 p0295 A79-28154
21 p0229 H79-15409	22 p0284 A79-26597	21 p0214 H79-13913	21 p0174 H79-10537
22 p0354 H79-19453	HGR-33-008-191	HSP C-1008	21 p0186 H79-11506
NAS8-32118	21 p0059 A79-13656	21 p0141 A79-17505	21 p0186 H79-11508
21 p0223 H79-14678	NOAA-2-35353	HSP DAR-75-09588-A01	21 p0189 H79-11541
NAS8-32149	21 p0042 A79-11875	22 p0367 H79-21530	21 p0213 H79-13571
21 p0043 A79-11974	NOAA-04-7-158-44113	HSP DCR-74-22044	21 p0216 H79-14242
NAS8-32242	22 p0331 H79-16140	21 p0154 A79-18472	22 p0361 H79-20500
21 p0173 H79-10520	NOAA-04-7-158-44120	HSP DCR-75-03578	22 p0361 H79-20503
22 p0360 H79-20493	21 p0151 A79-18108	21 p0082 A79-14979	22 p0361 H79-20507
NAS8-32244	ER PROJ. 098-038	HSP DMR-72-02977	22 p0373 H79-21679
21 p0204 H79-13491	22 p0338 H79-17011	22 p0249 A79-21690	W-7405-ENG-26
22 p0354 H79-19455	ER PROJ. 099-404	HSP DMR-75-08175	21 p0012 A79-10101
NAS8-32245	21 p0197 H79-12564	22 p0249 A79-21689	21 p0030 A79-10251
21 p0205 H79-13495	HRC A-2181	HSP DMR-76-01111	21 p0099 A79-16122
NAS8-32247	21 p0047 A79-12325	22 p0249 A79-21690	21 p0154 A79-18481
22 p0334 H79-16373	HRC A-4213	HSP EAR-74-22249	22 p0236 A79-20541
22 p0349 H79-18454	22 p0264 A79-23808	22 p0278 A79-26163	22 p0238 A79-20746
NAS8-32248	HRC A-7096	HSP ENG-75-02709	22 p0266 A79-24137
21 p0220 H79-14556	21 p0153 A79-18467	22 p0252 A79-22237	22 p0305 A79-30333
NAS8-32249	HRC A-7784	22 p0253 A79-22244	22 p0312 A79-31184
21 p0205 H79-13498	22 p0286 A79-27219	HSP ENG-75-19259	21 p0175 H79-10541
22 p0334 H79-16372	HRC 040-293	22 p0313 A79-31186	21 p0175 H79-10542
	22 p0264 A79-23809		21 p0184 H79-11487

# CONTRACT NUMBER INDEX

21 p0186 879-11511  
 21 p0192 879-11568  
 21 p0192 879-11570  
 21 p0193 879-11889  
 21 p0209 879-13528  
 21 p0214 879-13849  
 22 p0348 879-18447  
 22 p0369 879-21562  
 22 p0372 879-21640  
 W-7405-ENG-36  
 21 p0090 879-15859  
 21 p0175 879-10540  
 21 p0180 879-11236  
 21 p0185 879-11494  
 21 p0198 879-12568  
 21 p0208 879-13520  
 21 p0208 879-13521  
 21 p0214 879-13844  
 21 p0222 879-14602  
 21 p0232 879-15783  
 22 p0358 879-20458  
 22 p0365 879-21248  
 W-7405-ENG-48  
 21 p0011 879-10093  
 21 p0018 879-10148  
 21 p0018 879-10149  
 21 p0030 879-10249  
 21 p0030 879-10250  
 21 p0042 879-11880  
 21 p0046 879-12266  
 21 p0050 879-12849  
 21 p0070 879-14461  
 21 p0082 879-15138  
 21 p0083 879-15145  
 21 p0083 879-15171  
 21 p0085 879-15330  
 21 p0095 879-16130  
 21 p0114 879-16984  
 21 p0116 879-17262  
 21 p0155 879-18794  
 22 p0236 879-20542  
 22 p0241 879-20853  
 22 p0257 879-22977  
 22 p0285 879-26747  
 22 p0292 879-27887  
 22 p0304 879-29975  
 22 p0305 879-30595  
 21 p0174 879-10536  
 21 p0176 879-10547  
 21 p0181 879-11412  
 21 p0185 879-11497  
 21 p0187 879-11515  
 21 p0188 879-11534  
 21 p0189 879-11536  
 21 p0189 879-11538  
 21 p0189 879-11540  
 21 p0195 879-12439  
 21 p0204 879-13480  
 21 p0215 879-14165  
 21 p0215 879-14168  
 21 p0217 879-14377  
 22 p0341 879-17329  
 22 p0342 879-17337  
 22 p0369 879-21555  
 W-7405-ENG-82  
 21 p0082 879-15115  
 21 p0158 879-19735  
 W-7504-ENG-26  
 21 p0007 879-10065  
 WF57571301  
 21 p0201 879-13182  
 141-96-01-19  
 21 p0191 879-11560  
 505-04  
 21 p0215 879-14099  
 506-16-31  
 22 p0346 879-18287  
 516-50-20-01  
 21 p0200 879-13026

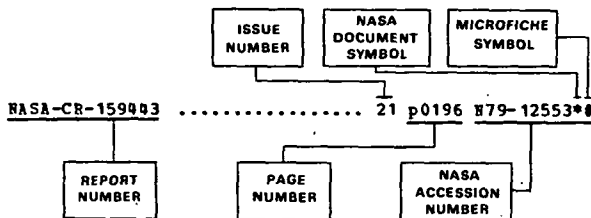
06 15  
 205E-824  
 15  
 15

# REPORT/ACCESSION INDEX

ENERGY / A Continuing Bibliography (Issue 22)

JULY 1979

## Typical Report/Accession Number Index Listing



Listings in this index are arranged alphanumerically by report number. The issue and page number indicate the actual Supplement and page where the citation may be located. The accession number denotes the number by which the citation is identified. An asterisk (\*) indicates that the item is a NASA report. A pound sign (#) indicates that the item is available on microfiche.

A-7642 ..... 22 p0346 N79-18287\*\*

AAS PAPER 78-022 ..... 21 p0035 A79-11558 #  
 AAS PAPER 78-144 ..... 22 p0243 A79-21259 #  
 AAS PAPER 78-153 ..... 22 p0243 A79-21265 #  
 AAS PAPER 78-154 ..... 22 p0243 A79-21266 #  
 AAS PAPER 78-166 ..... 22 p0243 A79-21270\*\*  
 AAS PAPER 78-176 ..... 22 p0243 A79-21273 #  
 AAS PAPER 78-182 ..... 22 p0243 A79-21275 #

AD-A056018 ..... 21 p0192 N79-11686 #  
 AD-A056021 ..... 21 p0193 N79-11688 #  
 AD-A056278 ..... 21 p0184 N79-11483 #  
 AD-A056491 ..... 21 p0184 N79-11485 #  
 AD-A056635 ..... 21 p0193 N79-11859 #  
 AD-A056806 ..... 21 p0171 N79-10216 #  
 AD-A057289 ..... 21 p0184 N79-11486 #  
 AD-A057987 ..... 21 p0197 N79-12562 #  
 AD-A058054 ..... 21 p0197 N79-12560 #  
 AD-A058200 ..... 21 p0197 N79-12563 #  
 AD-A058380 ..... 21 p0206 N79-13505 #  
 AD-A058456 ..... 21 p0206 N79-13504 #  
 AD-A058486 ..... 22 p0339 N79-17230 #  
 AD-A058550 ..... 21 p0203 N79-13375 #  
 AD-A058586 ..... 21 p0201 N79-13182 #  
 AD-A058626 ..... 21 p0206 N79-13506 #  
 AD-A058681 ..... 21 p0196 N79-12555 #  
 AD-A058795 ..... 21 p0206 N79-13503 #  
 AD-A059001 ..... 21 p0196 N79-12559 #  
 AD-A059061 ..... 21 p0205 N79-13502 #  
 AD-A059240 ..... 21 p0197 N79-12564 #  
 AD-A059295 ..... 21 p0220 N79-14561 #  
 AD-A059309 ..... 21 p0223 N79-14918 #  
 AD-A059365 ..... 21 p0220 N79-14559 #  
 AD-A059381 ..... 21 p0215 N79-14184 #  
 AD-A059534 ..... 21 p0216 N79-14232 #  
 AD-A059993 ..... 21 p0217 N79-14507 #  
 AD-A060081 ..... 21 p0216 N79-14235 #  
 AD-A060156 ..... 21 p0216 N79-14239 #  
 AD-A060218 ..... 21 p0216 N79-14231 #  
 AD-A060322 ..... 21 p0226 N79-15203 #  
 AD-A060351 ..... 21 p0230 N79-15413 #  
 AD-A060370 ..... 21 p0230 N79-15415 #  
 AD-A060429 ..... 21 p0230 N79-15414 #  
 AD-A060477 ..... 21 p0201 N79-13192 #  
 AD-A060586 ..... 21 p0226 N79-15145 #  
 AD-A061050 ..... 22 p0338 N79-17011 #  
 AD-A061071 ..... 22 p0342 N79-17341 #  
 AD-A061242 ..... 22 p0342 N79-17340 #  
 AD-A061503 ..... 22 p0338 N79-17019 #  
 AD-A061609 ..... 22 p0339 N79-17118 #  
 AD-A061724 ..... 22 p0352 N79-19305 #

AD-A061746 ..... 22 p0351 N79-18969 #  
 AD-A062387 ..... 22 p0357 N79-20279 #  
 AD-A062420 ..... 22 p0357 N79-20272 #  
 AD-A062609 ..... 22 p0356 N79-20109 #  
 AD-A062719 ..... 22 p0363 N79-20522 #  
 AD-A062751 ..... 22 p0366 N79-21406 #  
 AD-A062930 ..... 22 p0371 N79-21624 #  
 AD-A063714 ..... 22 p0365 N79-21233 #  
 AD-A063849 ..... 22 p0337 N79-16848 #

AD-E000199 ..... 21 p0201 N79-13182 #  
 AD-E000240 ..... 22 p0357 N79-20272 #

AEROCHER-TR-200 ..... 21 p0219 N79-14555\*\*

AFAPL-TR-77-93 ..... 21 p0216 N79-14231 #  
 AFAPL-TR-78-10 ..... 21 p0216 N79-14239 #  
 AFAPL-TR-78-16 ..... 21 p0220 N79-14561 #  
 AFAPL-TR-78-19-VOL-3-PT-1 ..... 22 p0342 N79-17341 #  
 AFAPL-TR-78-37 ..... 21 p0230 N79-15415 #  
 AFAPL-TR-78-41 ..... 21 p0230 N79-15414 #

APCEC-TR-78-6 ..... 21 p0206 N79-13506 #

APFDL-TR-78-96-VOL-1 ..... 22 p0351 N79-18969 #  
 APFDL-TR-78-96-VOL-2 ..... 22 p0356 N79-20109 #

AFIT-CI-78-113 ..... 21 p0220 N79-14559 #

AFIT-LSSB-8-78A ..... 21 p0223 N79-14918 #

APLRL-98 ..... 21 p0171 N79-10216 #  
 APLRL-105 ..... 21 p0216 N79-14232 #  
 APLRL-108 ..... 22 p0357 N79-20279 #

APHL-TR-78-100 ..... 21 p0226 N79-15203 #

APOSB-78-1145TR ..... 21 p0196 N79-12559 #  
 APOSB-78-1294TR ..... 21 p0215 N79-14184 #

AGARD-AR-111 ..... 22 p0337 N79-16848 #

AGARD-LS-96 ..... 21 p0201 N79-13192 #

AHS 78-25 ..... 21 p0152 A79-18151

AIAA PAPER 78-1716 ..... 21 p0060 A79-13833 #  
 AIAA PAPER 78-1750 ..... 21 p0060 A79-13853 #  
 AIAA PAPER 78-1751 ..... 21 p0089 A79-15849 #  
 AIAA PAPER 78-1752 ..... 21 p0060 A79-13854 #  
 AIAA PAPER 78-1753 ..... 21 p0060 A79-13855 #  
 AIAA PAPER 78-1755 ..... 21 p0060 A79-13856 #  
 AIAA PAPER 78-1756 ..... 21 p0060 A79-13857 #  
 AIAA PAPER 78-1757 ..... 21 p0060 A79-13858 #  
 AIAA PAPER 78-1758 ..... 21 p0060 A79-13859 #  
 AIAA PAPER 78-1759 ..... 21 p0061 A79-13860 #  
 AIAA PAPER 78-1760 ..... 21 p0061 A79-13861 #  
 AIAA PAPER 78-1761 ..... 21 p0061 A79-13862 #  
 AIAA PAPER 78-1762 ..... 21 p0061 A79-13863 #  
 AIAA PAPER 78-1763 ..... 21 p0061 A79-13864 #  
 AIAA PAPER 78-1766 ..... 21 p0061 A79-13865 #  
 AIAA PAPER 78-1767 ..... 21 p0061 A79-13866 #  
 AIAA PAPER 78-1768 ..... 21 p0061 A79-13867 #  
 AIAA PAPER 78-1770 ..... 21 p0062 A79-13868 #  
 AIAA PAPER 78-1771 ..... 21 p0062 A79-13869\*\*  
 AIAA PAPER 78-1773 ..... 21 p0062 A79-13870 #  
 AIAA PAPER 78-1774 ..... 21 p0062 A79-13871 #  
 AIAA PAPER 78-1775 ..... 21 p0062 A79-13872 #  
 AIAA PAPER 78-1776 ..... 21 p0062 A79-13873 #  
 AIAA PAPER 78-1779 ..... 21 p0062 A79-13874 #  
 AIAA PAPER 78-1781 ..... 21 p0063 A79-13876 #  
 AIAA PAPER 79-0112 ..... 21 p0156 A79-19538 #  
 AIAA PAPER 79-0113 ..... 21 p0156 A79-19539 #  
 AIAA PAPER 79-0114 ..... 21 p0156 A79-19540 #  
 AIAA PAPER 79-0115 ..... 21 p0157 A79-19541 #



# REPORT/ACCESSION NUMBER INDEX

ATIAA PAPER 79-0186	21	p0157	A79-19585 #	ASME PAPER 78-WA/PVP-1	21	p0162	A79-19832 #
ATIAA PAPER 79-0188	21	p0157	A79-19587 #	ASME PAPER 78-WA/SOL-1	21	p0162	A79-19834 #
ATIAA PAPER 79-0189	21	p0157	A79-19588 #	ASME PAPER 78-WA/SOL-2	21	p0162	A79-19835 #
ATIAA PAPER 79-0190	21	p0157	A79-19589 #	ASME PAPER 78-WA/SOL-3	21	p0162	A79-19836 #
ATIAA PAPER 79-0191	21	p0157	A79-19590 #	ASME PAPER 78-WA/SOL-4	21	p0162	A79-19837#
ATIAA PAPER 79-0289	21	p0157	A79-19649 #	ASME PAPER 78-WA/SOL-5	21	p0163	A79-19838#
ATIAA PAPER 79-0298	21	p0158	A79-19654 #	ASME PAPER 78-WA/SOL-7	21	p0163	A79-19839 #
ATIAA PAPER 79-0357	21	p0158	A79-19687 #	ASME PAPER 78-WA/SOL-8	21	p0163	A79-19840 #
ATIAA PAPER 79-0532	22	p0274	A79-25871**	ASME PAPER 78-WA/SOL-9	21	p0163	A79-19841 #
ATIAA PAPER 79-0534	22	p0273	A79-25854**	ASME PAPER 78-WA/SOL-10	21	p0163	A79-19842 #
ATIAA PAPER 79-0541	22	p0274	A79-25860 #	ASME PAPER 78-WA/SOL-11	21	p0163	A79-19843 #
ATIAA PAPER 79-0545	22	p0273	A79-25852**	ASME PAPER 78-WA/SOL-12	21	p0163	A79-19844 #
ATIAA 79-0733	22	p0298	A79-29007**	ASME PAPER 78-WA/SOL-13	21	p0163	A79-19845 #
ATIAA 79-7008	22	p0300	A79-29383**	ASME PAPER 78-WA/SOL-15	21	p0164	A79-19847 #
ATIAA 79-7009	22	p0300	A79-29384 #	ASME PAPER 78-WA/SOL-16	21	p0164	A79-19848 #
ATRESEARCH-31-2937	21	p0173	N79-10526**	ASME PAPER 78-WA/TS-4	21	p0164	A79-19849**
ALO-41/2	21	p0185	N79-11493 #	ASME PAPER 79-APH-5	22	p0298	A79-29064 #
ANL-K-3723-VOL-1	21	p0222	N79-14579 #	ASME PAPER 79-GT-3	22	p0306	A79-30502 #
ANL-HHD-78-2	21	p0197	N79-12564 #	ASME PAPER 79-GT-7	22	p0306	A79-30505 #
ANL-HHD-78-7	22	p0361	N79-20500 #	ASME PAPER 79-GT-8	22	p0306	A79-30506 #
ANL-HHD-78-8	22	p0361	N79-20507 #	ASME PAPER 79-GT-16	22	p0306	A79-30510 #
ANL-HHD-79-3	22	p0361	N79-20503 #	ASME PAPER 79-GT-38	22	p0309	A79-30554**
ANL/AA-11-VOL-1-DRAFT	21	p0174	N79-10537 #	ASME PAPER 79-GT-43	22	p0306	A79-30522 #
ANL/CEM/EE-77-5	21	p0216	N79-14242 #	ASME PAPER 79-GT-60	22	p0306	A79-30530 #
ANL/ECT-3-APP-A-PT-2	21	p0213	N79-13571 #	ASME PAPER 79-GT-64	22	p0306	A79-30532 #
APL-JHU-EQR-77-4	21	p0191	N79-11555 #	ASME PAPER 79-GT-67	22	p0307	A79-30533 #
APL/JHU-EQR-78-1	21	p0191	N79-11554 #	ASME PAPER 79-GT-72	22	p0307	A79-30536 #
APR-1	22	p0334	N79-16369**	ASME PAPER 79-GT-73	22	p0307	A79-30537 #
APR-4	22	p0351	N79-18815**	ASME PAPER 79-GT-141	22	p0309	A79-30555**
AR-1	22	p0330	N79-16139 #	ASME PAPER 79-SOL-1	22	p0307	A79-30539 #
AR-2	22	p0336	N79-16446 #	ASME PAPER 79-SOL-2	22	p0307	A79-30540 #
ARID-LANDS-RESOURCE-IP-12	21	p0211	N79-13549 #	ASME PAPER 79-SOL-3	22	p0307	A79-30541 #
ARL/MECH-ENG-TM-391	22	p0339	N79-17230 #	ASME PAPER 79-SOL-4	22	p0308	A79-30542 #
ASME PAPER 77-WA/ENER-1	21	p0030	A79-10253 #	ASME PAPER 79-SOL-7	22	p0308	A79-30543**
ASME PAPER 78-ENAS-2	21	p0048	A79-12551 #	ASME PAPER 79-SOL-9	22	p0308	A79-30544 #
ASME PAPER 78-ENAS-7	21	p0048	A79-12556 #	ASME PAPER 79-SOL-10	22	p0308	A79-30545 #
ASME PAPER 78-ENAS-20	21	p0048	A79-12569 #	ASME PAPER 79-SOL-11	22	p0308	A79-30546 #
ASME PAPER 78-ENAS-30	21	p0049	A79-12579 #	ASME PAPER 79-SOL-12	22	p0308	A79-30547 #
ASME PAPER 78-GT-13	21	p0031	A79-10257 #	ASME PAPER 79-SOL-14	22	p0308	A79-30548 #
ASME PAPER 78-GT-14	21	p0032	A79-10778 #	ASME PAPER 79-SOL-15	22	p0309	A79-30549 #
ASME PAPER 78-GT-85	22	p0255	A79-22338 #	ASME PAPER 79-SOL-16	22	p0309	A79-30550 #
ASME PAPER 78-GT-113	21	p0032	A79-10788 #	ASME PAPER 79-SOL-17	22	p0309	A79-30551**
ASME PAPER 78-GT-126	21	p0033	A79-10791 #	ASME PAPER 79-SOL-18	22	p0309	A79-30552 #
ASME PAPER 78-GT-145	21	p0031	A79-10269 #	ASSA-SE-B21/77	22	p0349	N79-18461 #
ASME PAPER 78-GT-146	21	p0033	A79-10799 #	ATR-78(8114)-2	21	p0220	N79-14558 #
ASME PAPER 78-GT-192	21	p0033	A79-10816 #	ATR-78(9409)-1	21	p0222	N79-14582 #
ASME PAPER 78-GT-198	21	p0033	A79-10818 #	AVRADCON-TR-78-41	21	p0215	N79-14099**
ASME PAPER 78-JPGCC-PWR-11	21	p0150	A79-18097 #	BERC/OP-76/32	21	p0226	N79-15304 #
ASME PAPER 78-JPGCC-PWR-12	21	p0150	A79-18098 #	BERC/OP-77/41	21	p0227	N79-15311 #
ASME PAPER 78-JPGCC-PWR-18	21	p0150	A79-18099 #	BERC/OP-77/42	21	p0226	N79-15305 #
ASME PAPER 78-RT-1	21	p0150	A79-18085 #	BERC/OP-77/44	21	p0227	N79-15312 #
ASME PAPER 78-WA/APC-2	21	p0158	A79-19735 #	BERC/OP-77/52	21	p0227	N79-15313 #
ASME PAPER 78-WA/APC-3	21	p0158	A79-19736 #	BERC/OP-77/53	21	p0228	N79-15314 #
ASME PAPER 78-WA/APC-7	21	p0158	A79-19738 #	BERC/OP-77/56	21	p0228	N79-15315 #
ASME PAPER 78-WA/APC-12	21	p0158	A79-19741 #	BERC/OP-77/57	21	p0227	N79-15306 #
ASME PAPER 78-WA/APC-13	21	p0159	A79-19742 #	BERC/OP-77/58	21	p0227	N79-15308 #
ASME PAPER 78-WA/DSC-19	21	p0159	A79-19765 #	BERC/OP-77/60	21	p0227	N79-15307 #
ASME PAPER 78-WA/DSC-21	21	p0159	A79-19766 #	BERC/OP-77/61	21	p0227	N79-15309 #
ASME PAPER 78-WA/DSC-32	21	p0159	A79-19771 #	BERC/OP-77/62	21	p0227	N79-15310 #
ASME PAPER 78-WA/ENER-2	21	p0159	A79-19775 #	BLL-RISLEY-TR-3395-(9091.9P)	22	p0347	N79-18442
ASME PAPER 78-WA/ENER-3	21	p0159	A79-19776 #	BLL-RTS-11317	22	p0345	N79-17984
ASME PAPER 78-WA/ENER-4	21	p0159	A79-19777 #	BLL-RTS-11512	22	p0347	N79-18439
ASME PAPER 78-WA/ENER-7	21	p0159	A79-19778 #	BH-IC-8772	21	p0190	N79-11547 #
ASME PAPER 78-WA/FU-3	21	p0160	A79-19787 #	BH-IC-8781	21	p0201	N79-13152 #
ASME PAPER 78-WA/FU-4	21	p0160	A79-19788 #	BH-HI-8293	21	p0213	N79-13590 #
ASME PAPER 78-WA/FU-9	21	p0160	A79-19789 #	BH-SP-2-78	21	p0217	N79-14521 #
ASME PAPER 78-WA/GT-1	21	p0160	A79-19790 #	BHFT-FB-T-77-17	22	p0342	N79-17344 #
ASME PAPER 78-WA/GT-2	21	p0160	A79-19791 #	BHFT-FE-T-77-35	22	p0349	N79-18456 #
ASME PAPER 78-WA/GT-8	21	p0160	A79-19796 #	BHFT-FB-T-77-42	22	p0349	N79-18457 #
ASME PAPER 78-WA/HT-21	21	p0161	A79-19808 #	BNI-NLVP-TM-77-2	22	p0345	N79-17898**
ASME PAPER 78-WA/HT-22	21	p0161	A79-19809 #	BNL-23101	21	p0221	N79-14578 #
ASME PAPER 78-WA/HT-23	21	p0161	A79-19810 #	BNL-24016	21	p0192	N79-11641 #
ASME PAPER 78-WA/HT-32	21	p0161	A79-19813 #	BNL-24368	21	p0208	N79-13525 #
ASME PAPER 78-WA/HT-33	21	p0161	A79-19814 #	BNI-50703	21	p0188	N79-11528 #
ASME PAPER 78-WA/HT-34	21	p0161	A79-19815 #	BNI-50708	21	p0213	N79-13572 #
ASME PAPER 78-WA/HT-59	21	p0161	A79-19824 #	BNI-50784	21	p0185	N79-11500 #
ASME PAPER 78-WA/HT-65	21	p0162	A79-19825 #	BNI-50799	21	p0185	N79-11499 #

# REPORT/ACCESSION NUMBER INDEX

BNL-50800	21	p0208	N79-13524	#	DOE/EDP-0024	21	p0175	N79-10545	#
BNL-50816	21	p0210	N79-13538	#	DOE/EIA-0014	21	p0177	N79-10560	#
BNL-50822	21	p0209	N79-13526	#	DOE/EIA-0031/1	21	p0189	N79-11542	#
BNL-50828	22	p0370	N79-21564	#	DOE/EIA-0058	21	p0177	N79-10565	#
BNL-50871	22	p0364	N79-20927	#	DOE/EIA-0103/18	22	p0362	N79-20509	#
BNL-50905	22	p0361	N79-20502	#	DOE/EIS-0004	21	p0213	N79-13574	#
BNWL-2137	21	p0170	N79-10179	#	DOE/ER-0022	22	p0337	N79-16893	#
BULL-62	22	p0335	N79-16380	#	DOE/ER-0023	22	p0367	N79-21538**	#
CAEC-002	22	p0372	N79-21628	#	DOE/ERA-0009	21	p0214	N79-13934	#
CASD-NAS-78-011	21	p0171	N79-10272**	#	DOE/ET-0014	21	p0176	N79-10546	#
CBNS-AE-10	21	p0222	N79-14586	#	DOE/ET-0018/1	21	p0207	N79-13518	#
CEEDO-TR-78-41	21	p0217	N79-14507	#	DOE/ET-0019/1	21	p0209	N79-13529	#
CERL-TR-E-139	22	p0363	N79-20522	#	DOE/ET-0035 (78)	21	p0197	N79-12567	#
CIO-78/2	21	p0222	N79-14581	#	DOE/ET-0046	21	p0175	N79-10544	#
CONF-771003-P2-VOL-2	21	p0176	N79-10551	#	DOE/ET-0059	21	p0207	N79-13517	#
CONF-771053-10	21	p0215	N79-14165	#	DOE/ET-0062	21	p0210	N79-13535	#
CONF-771203-5	21	p0175	N79-10540	#	DOE/EV-0014	21	p0213	N79-13573	#
CONF-771203-6	21	p0118	N79-17294	#	DOE/EV-0030	21	p0178	N79-10572	#
CONF-771207-1	21	p0232	N79-15830	#	DOE/JPL-1012-78/9	22	p0354	N79-19460**	#
CONF-771246-1	21	p0180	N79-11236	#	DOE/JPL-1012-78/13	22	p0355	N79-19462**	#
CONF-780109-6	21	p0189	N79-11541	#	DOE/JPL-1012-78/14	22	p0348	N79-18453**	#
CONF-780121-2	21	p0192	N79-11568	#	DOE/JPL-1024-78/1	22	p0359	N79-20490**	#
CONF-780222-5	21	p0186	N79-11506	#	DOE/JPL-1060-7	22	p0360	N79-20492**	#
CONF-780425-3	21	p0187	N79-11526	#	DOE/JPL-1060-15	22	p0368	N79-21548**	#
CONF-780426-2	21	p0186	N79-11508	#	DOE/JPL-1060-79/1	22	p0359	N79-20491**	#
CONF-780502-7	21	p0187	N79-11516	#	DOE/JPL-954355-78/3	22	p0359	N79-20483**	#
CONF-780508-19	21	p0214	N79-13872	#	DOE/JPL-954363-78/8	22	p0348	N79-18451**	#
CONF-780527-1	21	p0175	N79-10539	#	DOE/JPL-954373-78/7	21	p0219	N79-14580**	#
CONF-780550-4	21	p0187	N79-11517	#	DOE/JPL-954527-78/8	21	p0195	N79-12544**	#
CONF-780587-1	21	p0189	N79-11536	#	DOE/JPL-954796-77/1	22	p0335	N79-16378**	#
CONF-780615-2	21	p0181	N79-11412	#	DOE/JPL-954833-78/1	22	p0367	N79-21545**	#
CONF-780619-2	21	p0188	N79-11529	#	DOE/JPL-954862-78/4	21	p0219	N79-14555**	#
CONF-780619-4	21	p0176	N79-10550	#	DOE/JPL-954868-78/4	22	p0358	N79-20480**	#
CONF-780619-7	21	p0188	N79-11527	#	DOE/JPL-954886-79/1	22	p0357	N79-20281**	#
CONF-780619-8	21	p0198	N79-12570	#	DOE/JPL-954898-78/4	22	p0358	N79-20481**	#
CONF-780639-3	21	p0208	N79-13520	#	DOE/JPL-954899-78/3	21	p0200	N79-12970**	#
CONF-780639-4	21	p0208	N79-13521	#	DOE/JPL-954914-78/2	22	p0358	N79-20482**	#
CONF-780651-1	21	p0208	N79-13525	#	DOE/JPL-955089-79/1	22	p0359	N79-20485**	#
CONF-780801-8	21	p0189	N79-11538	#	DOE/JPL-955164-78/4	22	p0359	N79-20486**	#
CONF-780801-18	21	p0214	N79-13844	#	DOE/NASA/0012-78/1-VOL-1	21	p0205	N79-13496**	#
CONS/1197-9	22	p0369	N79-21556	#	DOE/NASA/0019-78/1	22	p0364	N79-21075**	#
CONS/4396-3	21	p0181	N79-11406**	#	DOE/NASA/0038-79/1	22	p0368	N79-21554**	#
CONS/5081-1	21	p0183	N79-11473**	#	DOE/NASA/0040-78/1	22	p0354	N79-19451**	#
COO-2477-11	21	p0231	N79-15431	#	DOE/NASA/0207-78/1	21	p0226	N79-15267**	#
COO-2577-13	21	p0209	N79-13530	#	DOE/NASA/0615-79/1	22	p0354	N79-19454**	#
COO-2577-14	21	p0206	N79-13507	#	DOE/NASA/1002-78/1	21	p0183	N79-11479**	#
COO-2597-4	21	p0188	N79-11533	#	DOE/NASA/1004-79/1	22	p0360	N79-20494**	#
COO-2617-4/2	21	p0204	N79-13378	#	DOE/NASA/1011-78/28	22	p0345	N79-17859**	#
COO-2857-1	21	p0184	N79-11490	#	DOE/NASA/1022-78/42	22	p0342	N79-17336**	#
COO-2908-4	22	p0358	N79-20459	#	DOE/NASA/1028-72/2	22	p0368	N79-21549**	#
COO-4181-1	21	p0193	N79-11890	#	DOE/NASA/1028-78/19	22	p0333	N79-16355**	#
COO-4227-2	21	p0170	N79-10178	#	DOE/NASA/1028-78/20	21	p0195	N79-12548**	#
COO-4389-1	21	p0213	N79-13569	#	DOE/NASA/1028-79/1	22	p0341	N79-17333**	#
CRN-780301-00087	21	p0189	N79-11542	#	DOE/NASA/1034-78/3	21	p0183	N79-11481**	#
CRN-780531-00226	21	p0177	N79-10565	#	DOE/NASA/1034-79/1	22	p0368	N79-21550**	#
CSA/LN-2286	21	p0230	N79-15428	#	DOE/NASA/1034-79/2	22	p0360	N79-20498**	#
CSIR-S-145	22	p0340	N79-17316	#	DOE/NASA/1040-78/30	22	p0337	N79-16721**	#
DELET-TR-78-8	21	p0206	N79-13504	#	DOE/NASA/2674-78/1	21	p0183	N79-11478**	#
DGLE PAPER 78-165	21	p0063	N79-14056	#	DOE/NASA/2674-78/2	22	p0341	N79-17335**	#
DGLR PAPER 78-167	21	p0063	N79-14054	#	DOE/NASA/7653-79/1	22	p0360	N79-20497**	#
DOC-78-008-4-000	22	p0335	N79-16377**	#	DOE/NASA/9773-78/1	21	p0173	N79-10525**	#
DOC-78SDS4252	21	p0196	N79-12554**	#	DOE/US-0001/2	21	p0180	N79-11242	#
DOC-78SDS4257	21	p0219	N79-14551**	#	DOT-HS-803324	21	p0226	N79-15304	#
DOE/CBN-780106-00003	21	p0177	N79-10560	#	DOT-HS-803325	21	p0226	N79-15305	#
DOE/CS-0009	21	p0186	N79-11503	#	DOT-HS-803326	21	p0227	N79-15311	#
DOE/CS-0010	21	p0208	N79-13519	#	DOT-HS-803327	21	p0227	N79-15312	#
DOE/EA-0033	22	p0362	N79-20514	#	DOT-HS-803328	21	p0227	N79-15313	#
DOE/EDP-006	21	p0188	N79-11531	#	DOT-HS-803329	21	p0228	N79-15314	#
DOE/EDP-0003	21	p0198	N79-12569	#	DOT-HS-803330	21	p0228	N79-15315	#
DOE/EDP-0004	21	p0187	N79-11522	#	DOT-HS-803331	21	p0227	N79-15308	#
DOE/EDP-0011	21	p0192	N79-11569	#	DOT-HS-803332	21	p0227	N79-15306	#
					DOT-HS-803333	21	p0227	N79-15309	#
					DOT-HS-803334	21	p0227	N79-15310	#
					DOT-HS-803335	21	p0227	N79-15307	#
					DOT-HTB-OPSO-78-01	21	p0181	N79-11447	#
					DOT-HTB-OPSO-78-02	21	p0181	N79-11446	#
					DOT-RSPA-DPB-20-78-13	21	p0177	N79-10561	#
					DOT-TSC-FRA-79-7-1-VOL-1	22	p0370	N79-21563	#
					DOT-TSC-NHTSA-78-8	21	p0226	N79-15304	#
					DOT-TSC-NHTSA-78-9	21	p0226	N79-15305	#
					DOT-TSC-NHTSA-78-11	21	p0227	N79-15312	#
					DOT-TSC-NHTSA-78-12	21	p0227	N79-15313	#
					DOT-TSC-NHTSA-78-13	21	p0228	N79-15314	#
					DOT-TSC-NHTSA-78-14	21	p0228	N79-15315	#

# REPORT/ACCESSION NUMBER INDEX

DOT-TSC-NHTSA-78-15 ..... 21 p0227 N79-15308 #  
DOT-TSC-NHTSA-78-16 ..... 21 p0227 N79-15306 #  
DOT-TSC-NHTSA-78-17 ..... 21 p0227 N79-15309 #  
DOT-TSC-NHTSA-78-18 ..... 21 p0227 N79-15310 #  
DOT-TSC-NHTSA-78-19 ..... 21 p0227 N79-15307 #  
DOW-PR-363 ..... 21 p0180 N79-11166 #  
DREO-R-787 ..... 22 p0339 N79-17118 #  
DRL-58-DRD-SE-7 ..... 21 p0219 N79-14540\*\*  
DSE/2426-19 ..... 21 p0174 N79-10535 #  
DSE/2459-2 ..... 21 p0221 N79-14577 #  
E-9413 ..... 22 p0333 N79-16355\*\*  
E-9647 ..... 21 p0204 N79-13472\*\*  
E-9713 ..... 21 p0169 N79-10122\*\*  
E-9762 ..... 21 p0215 N79-14099\*\*  
E-9775 ..... 22 p0345 N79-17859\*\*  
E-9777 ..... 21 p0183 N79-11481\*\*  
E-9779 ..... 21 p0183 N79-11479\*\*  
E-9780 ..... 21 p0193 N79-11955\*\*  
E-9783 ..... 21 p0183 N79-11478\*\*  
E-9788 ..... 21 p0183 N79-11477\*\*  
E-9799 ..... 22 p0341 N79-17335\*\*  
E-9800 ..... 22 p0329 N79-15961\*\*  
E-9811 ..... 22 p0342 N79-17336\*\*  
E-9818 ..... 21 p0195 N79-12548\*\*  
E-9828 ..... 21 p0194 N79-12086\*\*  
E-9833 ..... 22 p0333 N79-16357\*\*  
E-9834 ..... 22 p0338 N79-16930\*\*  
E-9835 ..... 21 p0229 N79-15403\*\*  
E-9846-1 ..... 22 p0357 N79-20118\*\*  
E-9848 ..... 22 p0337 N79-16721\*\*  
E-9898 ..... 22 p0330 N79-16136\*\*  
E-9905 ..... 21 p0229 N79-15410\*\*  
E-9907 ..... 22 p0360 N79-20494\*\*  
E-9913 ..... 22 p0357 N79-20114\*\*  
E-9921 ..... 21 p0229 N79-15411\*\*  
E-9925 ..... 22 p0368 N79-21549\*\*  
E-9957 ..... 22 p0368 N79-21550\*\*  
E-9970 ..... 22 p0360 N79-20498\*\*  
ECOM-77-158-2 ..... 21 p0193 N79-11890 #  
ECOM-78-147-1 ..... 22 p0368 N79-21551\*\*  
EDA/OEB-78-024 ..... 21 p0177 N79-10564 #  
END-78-38 ..... 21 p0190 N79-11546 #  
END-78-76 ..... 21 p0222 N79-14583 #  
END-78-81 ..... 22 p0355 N79-19472 #  
END-78-88 ..... 21 p0230 N79-15424 #  
EPA-450/2-77-031 ..... 21 p0194 N79-12251 #  
EPA-450/2-78-018 ..... 22 p0373 N79-21670 #  
EPA-450/3-78-007 ..... 21 p0178 N79-10591 #  
EPA-450/3-78-038 ..... 21 p0223 N79-14641 #  
EPA-600/1-78-063 ..... 22 p0364 N79-20727 #  
EPA-600/2-77-235 ..... 21 p0178 N79-10610 #  
EPA-600/2-78-004M ..... 21 p0223 N79-14635 #  
EPA-600/2-78-004X ..... 22 p0353 N79-19429 #  
EPA-600/2-78-114-PT-1 ..... 21 p0231 N79-15440 #  
EPA-600/2-78-149 ..... 21 p0231 N79-15439 #  
EPA-600/2-78-200 ..... 22 p0350 N79-18497 #  
EPA-600/2-78-211 ..... 22 p0336 N79-16439 #  
EPA-600/4-78-029 ..... 21 p0200 N79-12602 #  
EPA-600/4-78-039 ..... 21 p0232 N79-15473 #  
EPA-600/7-77-130 ..... 22 p0344 N79-17378 #  
EPA-600/7-78-011 ..... 21 p0195 N79-12424 #  
EPA-600/7-78-020 ..... 21 p0211 N79-13588 #  
EPA-600/7-78-023 ..... 22 p0373 N79-21671 #  
EPA-600/7-78-032A ..... 21 p0200 N79-12606 #  
EPA-600/7-78-047-VOL-1 ..... 21 p0178 N79-10574 #  
EPA-600/7-78-068 ..... 22 p0338 N79-17025 #  
EPA-600/7-78-073 ..... 21 p0171 N79-10243 #  
EPA-600/7-78-084 ..... 21 p0223 N79-14643 #  
EPA-600/7-78-086 ..... 21 p0224 N79-14946 #  
EPA-600/7-78-089 ..... 21 p0216 N79-14243 #  
EPA-600/7-78-091 ..... 21 p0178 N79-10595 #  
EPA-600/7-78-093 ..... 21 p0199 N79-12601 #  
EPA-600/7-78-098 ..... 21 p0178 N79-10603 #  
EPA-600/7-78-101 ..... 21 p0178 N79-10604 #  
EPA-600/7-78-107 ..... 21 p0179 N79-10968 #  
EPA-600/7-78-108 ..... 21 p0213 N79-13591 #  
EPA-600/7-78-119 ..... 21 p0232 N79-15864 #  
EPA-600/7-78-129 ..... 21 p0223 N79-14618 #  
EPA-600/7-78-134 ..... 21 p0232 N79-15479 #  
EPA-600/7-78-146 ..... 21 p0213 N79-13592 #

EPA-600/7-78-149 ..... 21 p0228 N79-15379 #  
EPA-600/7-78-150 ..... 22 p0330 N79-16139 #  
EPA-600/7-78-153A ..... 22 p0346 N79-18061 #  
EPA-600/7-78-159 ..... 22 p0339 N79-17026 #  
EPA-600/7-78-160-VOL-5 ..... 22 p0336 N79-16437 #  
EPA-600/7-78-165 ..... 21 p0232 N79-15474 #  
EPA-600/7-78-171 ..... 22 p0339 N79-17027 #  
EPA-600/7-78-173A ..... 22 p0372 N79-21625 #  
EPA-600/7-78-175 ..... 22 p0336 N79-16446 #  
EPA-600/7-78-184A ..... 22 p0344 N79-17364 #  
EPA-600/7-78-184B ..... 22 p0344 N79-17365 #  
EPA-600/7-78-186A ..... 22 p0350 N79-18487 #  
EPA-600/7-78-186B ..... 22 p0350 N79-18488 #  
EPA-600/7-78-186C ..... 22 p0350 N79-18489 #  
EPA-600/7-78-190 ..... 22 p0352 N79-19173 #  
EPA-600/7-78-197A ..... 22 p0351 N79-18834 #  
EPA-600/7-78-197B-VOL-2 ..... 22 p0356 N79-19496 #  
EPA-600/7-78-202 ..... 22 p0373 N79-21662 #  
EPA-600/7-78-204 ..... 22 p0365 N79-21224 #  
EPA-600/7-78-222 ..... 22 p0373 N79-21682 #  
EPA-600/7-79-005 ..... 22 p0373 N79-21661 #  
EPA-600/8-78-015 ..... 22 p0372 N79-21626 #  
EPA-600/9-78-022 ..... 22 p0346 N79-18352 #  
EPA-600/9-78-023 ..... 22 p0349 N79-18464 #  
EPRI-AF-753 ..... 21 p0185 N79-11498 #  
EPRI-AF-782 ..... 21 p0180 N79-11238 #  
EPRI-EA-620-VOL-1 ..... 21 p0189 N79-11539 #  
EPRI-EA-623 ..... 21 p0203 N79-13281 #  
EPRI-EA-745 ..... 21 p0181 N79-11454 #  
EPRI-EM-683 ..... 21 p0186 N79-11502 #  
EPRI-EM-751 ..... 21 p0186 N79-11501 #  
EPRI-PP-557 ..... 21 p0200 N79-13149 #  
EPRI-RP1082-1-VOL-1 ..... 21 p0205 N79-13496\*\*  
EP43-79-5 ..... 22 p0360 N79-20495\*\*  
ERDA/JPL-954343-78/13 ..... 21 p0219 N79-14541\*\*  
ERDA/JPL-954471-77/3 ..... 21 p0218 N79-14537\*\*  
ERDA/JPL-954654-79/1 ..... 22 p0357 N79-20282\*\*  
ERHQ/2322-77/4 ..... 21 p0174 N79-10538 #  
ER79-4032 ..... 22 p0345 N79-17896\*\*  
ESA-CR(P)-1112 ..... 22 p0335 N79-16379 #  
ESD-TR-78-97 ..... 21 p0226 N79-15145 #  
ESS/SS-878 ..... 22 p0335 N79-16379 #  
E79-10095 ..... 22 p0339 N79-17289\*\*  
E79-10099 ..... 22 p0347 N79-18373\*\*  
E79-10102 ..... 22 p0339 N79-17291\*\*  
FAA-NA-77-17 ..... 21 p0196 N79-12555 #  
FAA-RD-78-87 ..... 21 p0196 N79-12555 #  
FCR-0398 ..... 21 p0196 N79-12553\*\*  
FCR-0783-VOL-1 ..... 22 p0361 N79-20505 #  
FE-1534-50 ..... 21 p0180 N79-11166 #  
FE-2025-3 ..... 21 p0192 N79-11607 #  
FE-2206-14 ..... 21 p0180 N79-11239 #  
FE-2215-11 ..... 22 p0362 N79-20511 #  
FE-2248-19 ..... 22 p0369 N79-21558 #  
FE-2321-12 ..... 21 p0216 N79-14240 #  
FE-2334-6 ..... 21 p0171 N79-10238 #  
FE-2341-8 ..... 22 p0362 N79-20512 #  
FE-2524-8 ..... 22 p0363 N79-20517 #  
FE-2613-6-VOL-1 ..... 22 p0362 N79-20515 #  
FE-2613-6-VOL-2A ..... 22 p0363 N79-20516 #  
FE-2614-2-PT-1 ..... 22 p0369 N79-21560 #  
FE-2614-2-PT-2 ..... 22 p0369 N79-21561 #  
FE-2664-7 ..... 21 p0180 N79-11223 #  
FE-2706-08 ..... 22 p0362 N79-20510 #  
FE-3087-2 ..... 22 p0363 N79-20518 #  
FE-9036-3 ..... 21 p0204 N79-13474\*\*  
FE-23417 ..... 22 p0365 N79-21310 #  
FEA/B-77/181 ..... 21 p0221 N79-14576 #  
FJSRL-TR-78-0010 ..... 22 p0352 N79-19305 #

# REPORT/ACCESSION NUMBER INDEX

PPL-12 ..... 21 p0194 N79-12239 #

FRA/ORD-78-1-VOL-1 ..... 22 p0370 N79-21563 #

PSLUPCA-34 ..... 22 p0332 N79-16342 #

FWS/OBS-78/20 ..... 22 p0340 N79-17311 #

FWS/OBS-78/25 ..... 22 p0339 N79-17309 #

FWS/OBS-78/26 ..... 21 p0231 N79-15438 #

FWS/OBS-78/54 ..... 21 p0199 N79-12576 #

FWS/OBS-78/75 ..... 22 p0373 N79-21679 #

FWS/OBS-78/77 ..... 22 p0349 N79-18462 #

GA-A-14311 ..... 22 p0331 N79-16261 #

GA-A-14876 ..... 21 p0214 N79-13871 #

GA-A-14883 ..... 21 p0187 N79-11526 #

GA-A-14946 ..... 21 p0214 N79-13872 #

GE78TAP-60-VOL-1 ..... 21 p0205 N79-13496\*\*

GPERC/IC-77/1 ..... 21 p0216 N79-14261 #

GPO-21-616 ..... 21 p0228 N79-15400 #

GPO-22-673 ..... 22 p0333 N79-16352 #

GPO-23-254 ..... 22 p0342 N79-17339 #

GPO-23-434 ..... 21 p0228 N79-15398 #

GPO-23-442 ..... 21 p0228 N79-15399 #

GPO-23-876 ..... 21 p0224 N79-15105 #

GPO-24-067 ..... 22 p0333 N79-16353 #

GPO-34-175 ..... 21 p0214 N79-13932 #

GPO-35-823 ..... 21 p0232 N79-15815 #

GPO-41-646 ..... 22 p0364 N79-20928 #

GPO-98-809 ..... 22 p0351 N79-18810 #

H-PRINT-95-42 ..... 21 p0228 N79-15399 #

H-PRINT-95-43 ..... 21 p0228 N79-15400 #

H-PRINT-95-48 ..... 21 p0228 N79-15398 #

H-PRINT-95-51 ..... 22 p0333 N79-16352 #

H-REPT-96-52 ..... 22 p0364 N79-20928 #

HCP/H1011-02 ..... 21 p0215 N79-13937\*\*

HCP/H2098-01 ..... 21 p0180 N79-11237 #

HCP/H2121-01 ..... 21 p0210 N79-13540 #

HCP/H2528-1 ..... 21 p0209 N79-13534 #

HCP/H2835-01 ..... 22 p0351 N79-18817 #

HCP/H2923-01 ..... 21 p0201 N79-13190 #

HCP/H05017-01/1 ..... 21 p0210 N79-13536 #

HCP/H70065-01/1 ..... 21 p0207 N79-13512 #

HCP/H70066-01/2 ..... 21 p0207 N79-13513 #

HCP/H4024-01 ..... 22 p0337 N79-16895\*\*

HCP/H2583-01/2 ..... 21 p0203 N79-13280 #

HCP/H3073-01 ..... 21 p0193 N79-11887 #

HCP/H22221-01/1-VOL-1 ..... 21 p0207 N79-13511 #

HCP/H22221-01/2-2 ..... 21 p0207 N79-13510 #

HCP/H22221-01/3 ..... 21 p0189 N79-11535 #

HCP/H060505-01 ..... 21 p0184 N79-11489 #

HCP/H1260-01/1 ..... 21 p0207 N79-13514 #

HCP/H1260-01/2 ..... 21 p0207 N79-13515 #

HCP/H1737-01 ..... 21 p0201 N79-13189 #

HCP/H3684-01/1 ..... 21 p0201 N79-13191 #

HCP/H3684-01/2 ..... 21 p0194 N79-12249 #

HI-78336 ..... 22 p0368 N79-21554\*\*

HSER-7383 ..... 21 p0173 N79-10525\*\*

HUD-0000190 ..... 22 p0336 N79-16497 #

HUD-0000193 ..... 22 p0331 N79-16188 #

HUD-0000194 ..... 22 p0355 N79-19468 #

HUD-0000195 ..... 22 p0331 N79-16150 #

IAP PAPER 78-SL-45 ..... 21 p0035 A79-11356

IAP PAPER 78-39 ..... 21 p0034 A79-11216

IAP PAPER 78-42 ..... 21 p0034 A79-11217

IAP PAPER 78-43 ..... 21 p0035 A79-11218\*

IAP PAPER 78-190 ..... 21 p0035 A79-11287

IAP PAPER 78-192 ..... 21 p0035 A79-11288

IAP PAPER 78-217 ..... 21 p0035 A79-11298

ICP-1151 ..... 22 p0369 N79-21559 #

IDO-1622-4 ..... 21 p0208 N79-13523 #

IEEE PAPER P 78 672-8 ..... 22 p0304 A79-29939

ILLDOE-78/09 ..... 22 p0363 N79-20526 #

IMMR37-PR6-78 ..... 21 p0198 N79-12574 #

IMMR38-PD21-78 ..... 21 p0230 N79-15423 #

INDEX-78-711-ZLG ..... 21 p0226 N79-15207 #

IPR-5 ..... 22 p0342 N79-17340 #

ISBN-0-309-02677-6 ..... 21 p0232 N79-15868 #

ISBN-0-89779-006-5 ..... 21 p0230 N79-15423 #

ISBN-90-6144-079-3 ..... 22 p0350 N79-18758 #

ISBN-92-63-10467-0 ..... 21 p0192 N79-11613 #

ISBN-92-835-1258-8 ..... 22 p0337 N79-16848 #

ISBN-92-835-1297-9 ..... 21 p0201 N79-13192 #

ISSN-0110-1692 ..... 21 p0187 N79-11513 #

JPL-PUB-78-15-VOL-4 ..... 21 p0195 N79-12543\*\*

JPL-PUB-78-28 ..... 21 p0202 N79-13263\*\*

JPL-PUB-78-82 ..... 21 p0204 N79-13478\*\*

JPL-PUB-78-95 ..... 21 p0205 N79-13501\*\*

JPL-PUB-78-97 ..... 22 p0355 N79-19462\*\*

JPL-PUB-78-101 ..... 21 p0203 N79-13370\*\*

JPL-PUB-78-106 ..... 22 p0359 N79-20490\*\*

JPL-PUB-79-1-VOL-1 ..... 22 p0360 N79-20492\*\*

JPL-PUB-79-6 ..... 22 p0354 N79-19449\*\*

JPL-PUB-79-7 ..... 22 p0359 N79-20491\*\*

JPL-PUB-79-9 ..... 22 p0354 N79-19450\*\*

JPL-PUB-79-12-VOL-1 ..... 22 p0368 N79-21548\*\*

JPL-900-800 ..... 21 p0196 N79-12558\*\*

JPL-900-822 ..... 21 p0196 N79-12557\*\*

JPL-1060-14 ..... 22 p0335 N79-16377\*\*

JPL-5101-76 ..... 22 p0354 N79-19460\*\*

JPL-5101-81 ..... 22 p0355 N79-19462\*\*

JPL-5101-83 ..... 22 p0348 N79-18453\*\*

JPL-5104-26 ..... 22 p0360 N79-20492\*\*

JPL-954374-78/1 ..... 22 p0333 N79-16365\*\*

JPL-954888-78/4 ..... 22 p0334 N79-16369\*\*

JPL-955077-78/3 ..... 22 p0334 N79-16368\*\*

L-12427 ..... 21 p0191 N79-11560\*\*

LA-UR-77-1162 ..... 21 p0090 A79-15859 #

LA-UR-77-2694 ..... 21 p0118 A79-47294\*\*

LA-UR-77-2744 ..... 21 p0175 N79-10540\*\*

LA-UR-78-652 ..... 21 p0180 N79-11236 #

LA-UR-78-1437 ..... 21 p0214 N79-13844\*\*

LA-UR-78-1493 ..... 21 p0208 N79-13520 #

LA-UR-78-1494 ..... 21 p0208 N79-13521 #

LA-7033-PR ..... 21 p0232 N79-15783 #

LA-7041 ..... 21 p0185 N79-11494 #

LA-7048-PR ..... 21 p0222 N79-14602 #

LA-7235-MS ..... 21 p0198 N79-12568 #

LA-7656-MS ..... 22 p0358 N79-20458 #

LA-7657-MS ..... 22 p0365 N79-21248 #

LBL-6889 ..... 21 p0176 N79-10547 #

LBL-7000 ..... 21 p0174 N79-10536 #

LBL-7025 ..... 21 p0188 N79-11534 #

LBL-7803 ..... 21 p0187 N79-11515 #

LBL-7808 ..... 21 p0189 N79-11540 #

LBL-7896 ..... 22 p0341 N79-17329 #

LBL-8483 ..... 22 p0369 N79-21555 #

LC-77-92794 ..... 21 p0171 N79-10240 #

LC-78-13538 ..... 21 p0232 N79-15868 #

LC-78-110283 ..... 22 p0355 N79-19470 #

LC-78-600053 ..... 21 p0191 N79-11556 #

LC-78-600056 ..... 21 p0190 N79-11544 #

LC-78-600060 ..... 21 p0218 N79-14530 #

LC-78-600096 ..... 22 p0340 N79-17311 #

LC-78-600108 ..... 22 p0349 N79-18462 #

LC-78-600138 ..... 22 p0372 N79-21632 #

LC-78-606072 ..... 22 p0335 N79-16384 #

LHSC-D614944-PT-3-VOL-2 ..... 22 p0345 N79-17890\*\*

LHSC-D632522 ..... 22 p0358 N79-20481\*\*

LHSC-D665407 ..... 21 p0219 N79-14546\*\*

LHSC-D665410 ..... 21 p0194 N79-12136\*\*

LHSC-D673466-VOL-1 ..... 22 p0366 N79-21334\*\*

LHSC-D673466-VOL-2 ..... 22 p0366 N79-21335\*\*

M-267 ..... 21 p0223 N79-14679\*\*

M-280 ..... 21 p0223 N79-14678\*\*

MERC/RI-78/3 ..... 21 p0175 N79-10543 #

# REPORT/ACCESSION NUMBER INDEX

HITSG-78-11 ..... 21 p0226 N79-15207 #

HNL-TR-77-57C ..... 21 p0230 N79-15422 #

HNL-TR-78-18 ..... 21 p0199 N79-12577 #

HPR-022 ..... 21 p0206 N79-13505 #

HRC-DA-709 ..... 22 p0353 N79-19429 #

HRC-DA-748 ..... 21 p0223 N79-14635 #

HRC-DA-762 ..... 21 p0223 N79-14643 #

HRC-DA-783 ..... 21 p0178 N79-10603 #

HTR-17 ..... 21 p0180 N79-11223 #

HTR-7593 ..... 21 p0220 N79-14565 #

NASA-CASE-LEW-12236-2 ..... 21 p0217 N79-14528\*

NASA-CASE-LEW-12552-2 ..... 21 p0182 N79-11472\*

NASA-CASE-LEW-12780-1 ..... 22 p0357 N79-20179\*

NASA-CASE-LEW-12819-1 ..... 21 p0182 N79-11467\*

NASA-CASE-MFS-23051-1 ..... 21 p0172 N79-10422\*

NASA-CASE-MFS-23518-1 ..... 21 p0182 N79-11469\*

NASA-CASE-NPO-13579-4 ..... 21 p0217 N79-14529\*

NASA-CASE-NPO-13732-1 ..... 21 p0172 N79-10513\*

NASA-CASE-NPO-13817-1 ..... 21 p0182 N79-11471\*

NASA-CASE-NPO-13904-1 ..... 21 p0179 N79-11152\*

NASA-CASE-NPO-14058-1 ..... 22 p0348 N79-18443\*

NASA-CASE-NPO-14126-1 ..... 21 p0182 N79-11470\*

NASA-CASE-NPO-14231-1 ..... 22 p0356 N79-19521\*

NASA-CASE-NPO-14490-1 ..... 22 p0348 N79-18445\*

NASA-CASE-NPO-14619-1 ..... 22 p0362 N79-20513\*

NASA-CASE-WOO-00428-1 ..... 22 p0352 N79-19186\*

NASA-CASE-XGS-00829-1 ..... 22 p0353 N79-19447\*

NASA-CP-2041 ..... 22 p0370 N79-21565\*\*

NASA-CP-2058 ..... 21 p0169 N79-10122\*\*

NASA-CP-2067 ..... 22 p0329 N79-15961\*\*

NASA-CR-3093 ..... 21 p0215 N79-14192\*\*

NASA-CR-3111 ..... 22 p0363 N79-20519\*\*

NASA-CR-135389 ..... 21 p0173 N79-10525\*\*

NASA-CR-135396 ..... 21 p0194 N79-12084\*\*

NASA-CR-145070 ..... 21 p0200 N79-13026\*\*

NASA-CR-150619 ..... 21 p0173 N79-10520\*\*

NASA-CR-150681 ..... 22 p0330 N79-16037\*\*

NASA-CR-150685 ..... 21 p0225 N79-15140\*\*

NASA-CR-150700 ..... 22 p0329 N79-16036\*\*

NASA-CR-150702 ..... 21 p0225 N79-15142\*\*

NASA-CR-150733 ..... 21 p0225 N79-15137\*\*

NASA-CR-150788 ..... 21 p0173 N79-10523\*\*

NASA-CR-150803 ..... 21 p0172 N79-10516\*\*

NASA-CR-150804 ..... 21 p0172 N79-10515\*\*

NASA-CR-150812 ..... 21 p0172 N79-10517\*\*

NASA-CR-150814 ..... 21 p0172 N79-10518\*\*

NASA-CR-150818 ..... 21 p0204 N79-13493\*\*

NASA-CR-150819 ..... 21 p0173 N79-10521\*\*

NASA-CR-150820 ..... 21 p0205 N79-13499\*\*

NASA-CR-150827 ..... 21 p0183 N79-11475\*\*

NASA-CR-150828 ..... 21 p0196 N79-12552\*\*

NASA-CR-150831 ..... 21 p0173 N79-10522\*\*

NASA-CR-150839 ..... 22 p0333 N79-16361\*\*

NASA-CR-150840 ..... 22 p0333 N79-16359\*\*

NASA-CR-150841 ..... 21 p0205 N79-13500\*\*

NASA-CR-150842 ..... 21 p0204 N79-13492\*\*

NASA-CR-150849 ..... 21 p0229 N79-15402\*\*

NASA-CR-150850 ..... 21 p0205 N79-13498\*\*

NASA-CR-150851 ..... 21 p0204 N79-13491\*\*

NASA-CR-150852 ..... 21 p0205 N79-13494\*\*

NASA-CR-150853 ..... 21 p0229 N79-15409\*\*

NASA-CR-150854 ..... 21 p0205 N79-13495\*\*

NASA-CR-150856 ..... 21 p0229 N79-15405\*\*

NASA-CR-150857 ..... 21 p0228 N79-15401\*\*

NASA-CR-150858 ..... 21 p0220 N79-14557\*\*

NASA-CR-150859 ..... 21 p0220 N79-14556\*\*

NASA-CR-150860 ..... 22 p0333 N79-16360\*\*

NASA-CR-150861 ..... 22 p0334 N79-16372\*\*

NASA-CR-150866 ..... 22 p0339 N79-17289\*\*

NASA-CR-150867 ..... 22 p0334 N79-16373\*\*

NASA-CR-150868 ..... 21 p0229 N79-15404\*\*

NASA-CR-150869 ..... 22 p0354 N79-19455\*\*

NASA-CR-150870 ..... 21 p0229 N79-15406\*\*

NASA-CR-150871 ..... 22 p0354 N79-19453\*\*

NASA-CR-150872 ..... 22 p0341 N79-17331\*\*

NASA-CR-150874 ..... 22 p0334 N79-16370\*\*

NASA-CR-150875 ..... 22 p0341 N79-17332\*\*

NASA-CR-150876 ..... 22 p0349 N79-18454\*\*

NASA-CR-150880 ..... 21 p0215 N79-14143\*\*

NASA-CR-150899 ..... 22 p0341 N79-17328\*\*

NASA-CR-150900 ..... 22 p0348 N79-18449\*\*

NASA-CR-151831 ..... 21 p0171 N79-10272\*\*

NASA-CR-151856 ..... 21 p0194 N79-12130\*\*

NASA-CR-151859 ..... 21 p0194 N79-12136\*\*

NASA-CR-151866 ..... 22 p0330 N79-16039\*\*

NASA-CR-151871 ..... 22 p0330 N79-16057\*\*

NASA-CR-157840 ..... 21 p0203 N79-13370\*\*

NASA-CR-157841 ..... 21 p0205 N79-13501\*\*

NASA-CR-157843 ..... 21 p0202 N79-13263\*\*

NASA-CR-157934 ..... 21 p0195 N79-12543\*\*

NASA-CR-157939 ..... 21 p0195 N79-12544\*\*

NASA-CR-157951 ..... 21 p0196 N79-12558\*\*

NASA-CR-157952 ..... 21 p0196 N79-12557\*\*

NASA-CR-157953 ..... 21 p0200 N79-12970\*\*

NASA-CR-157970 ..... 21 p0204 N79-13474\*\*

NASA-CR-158015 ..... 22 p0333 N79-16351\*\*

NASA-CR-158028 ..... 21 p0219 N79-14548\*\*

NASA-CR-158032 ..... 21 p0219 N79-14546\*\*

NASA-CR-158034 ..... 21 p0219 N79-14541\*\*

NASA-CR-158037 ..... 21 p0219 N79-14555\*\*

NASA-CR-158038 ..... 21 p0219 N79-14540\*\*

NASA-CR-158039 ..... 21 p0218 N79-14537\*\*

NASA-CR-158046 ..... 21 p0219 N79-14551\*\*

NASA-CR-158055 ..... 22 p0347 N79-18373\*\*

NASA-CR-158058 ..... 22 p0339 N79-17291\*\*

NASA-CR-158066 ..... 21 p0225 N79-15138\*\*

NASA-CR-158067 ..... 21 p0225 N79-15139\*\*

NASA-CR-158068 ..... 21 p0225 N79-15141\*\*

NASA-CR-158082 ..... 22 p0333 N79-16365\*\*

NASA-CR-158089 ..... 22 p0335 N79-16378\*\*

NASA-CR-158090 ..... 22 p0334 N79-16366\*\*

NASA-CR-158093 ..... 22 p0335 N79-16377\*\*

NASA-CR-158095 ..... 22 p0334 N79-16368\*\*

NASA-CR-158096 ..... 22 p0334 N79-16369\*\*

NASA-CR-158109 ..... 22 p0337 N79-16895\*\*

NASA-CR-158117 ..... 22 p0348 N79-18453\*\*

NASA-CR-158120 ..... 22 p0348 N79-18451\*\*

NASA-CR-158130 ..... 22 p0347 N79-18424\*\*

NASA-CR-158167 ..... 22 p0345 N79-17898\*\*

NASA-CR-158172 ..... 22 p0354 N79-19459\*\*

NASA-CR-158174 ..... 22 p0354 N79-19460\*\*

NASA-CR-158228 ..... 22 p0354 N79-19450\*\*

NASA-CR-158229 ..... 22 p0354 N79-19449\*\*

NASA-CR-158246 ..... 22 p0359 N79-20491\*\*

NASA-CR-158250 ..... 22 p0355 N79-19462\*\*

NASA-CR-158358 ..... 22 p0359 N79-20486\*\*

NASA-CR-158359 ..... 22 p0359 N79-20484\*\*

NASA-CR-158360 ..... 22 p0358 N79-20480\*\*

NASA-CR-158362 ..... 22 p0358 N79-20482\*\*

NASA-CR-158363 ..... 22 p0359 N79-20485\*\*

NASA-CR-158365 ..... 22 p0358 N79-20481\*\*

NASA-CR-158366 ..... 22 p0357 N79-20281\*\*

NASA-CR-158368 ..... 22 p0367 N79-21545\*\*

NASA-CR-158372 ..... 22 p0367 N79-21547\*\*

NASA-CR-158376 ..... 22 p0357 N79-20282\*\*

NASA-CR-158379 ..... 22 p0359 N79-20483\*\*

NASA-CR-158420 ..... 22 p0359 N79-20490\*\*

NASA-CR-158421 ..... 22 p0360 N79-20492\*\*

NASA-CR-158425 ..... 22 p0368 N79-21548\*\*

NASA-CR-158476 ..... 22 p0367 N79-21543\*\*

NASA-CR-158991 ..... 22 p0346 N79-18057\*\*

NASA-CR-159397 ..... 21 p0183 N79-11473\*\*

NASA-CR-159411-VOL-1 ..... 21 p0205 N79-13496\*\*

NASA-CR-159431 ..... 22 p0334 N79-16374\*\*

NASA-CR-159436 ..... 21 p0181 N79-11406\*\*

NASA-CR-159440 ..... 21 p0173 N79-10526\*\*

NASA-CR-159443 ..... 21 p0196 N79-12553\*\*

NASA-CR-159447 ..... 21 p0196 N79-12554\*\*

NASA-CR-159454 ..... 21 p0200 N79-13050\*\*

NASA-CR-159465 ..... 22 p0354 N79-19454\*\*

NASA-CR-159477 ..... 22 p0354 N79-19451\*\*

NASA-CR-159479 ..... 22 p0368 N79-21554\*\*

NASA-CR-159488 ..... 22 p0337 N79-16850\*\*

NASA-CR-159523-VOL-1 ..... 22 p0366 N79-21334\*\*

NASA-CR-159523-VOL-2 ..... 22 p0366 N79-21335\*\*

NASA-CR-159529 ..... 22 p0359 N79-20487\*\*

NASA-CR-159530 ..... 22 p0360 N79-20497\*\*

NASA-CR-159533 ..... 22 p0364 N79-21075\*\*

NASA-CR-160091 ..... 22 p0337 N79-16892\*\*

NASA-CR-160159 ..... 22 p0371 N79-21622\*\*

NASA-CR-161093 ..... 22 p0348 N79-18450\*\*

NASA-CR-161104 ..... 22 p0348 N79-18448\*\*

NASA-CR-161146 ..... 22 p0345 N79-17890\*\*

NASA-CR-161151 ..... 22 p0371 N79-21619\*\*

NASA-CR-161161 ..... 22 p0345 N79-17896\*\*

# REPORT/ACCESSION NUMBER INDEX

NASA-CR-161165	22	p0360	N79-20493**	NBSIR-78-1532	22	p0343	N79-17350 *
NASA-CR-161166	22	p0371	N79-21621**	NBSIR-78-1535	22	p0363	N79-20524 *
NASA-CR-161173	22	p0352	N79-19071**	NBSIR-78-1542	22	p0343	N79-17351 *
NASA-CR-161185	22	p0368	N79-21551**	NBSIR-78-1562	22	p0372	N79-21630 *
NASA-CR-161186	22	p0368	N79-21552**				
NASA-CR-161200	22	p0360	N79-20499**	NCAR-3141-78/1	21	p0179	N79-10679 *
NASA-CR-161201	22	p0358	N79-20478**	NEPP-3-A-APP	21	p0198	N79-12573 *
NASA-TH-75369	21	p0183	N79-11474**	NMEI-76/173	21	p0226	N79-15177 *
NASA-TH-75424	22	p0364	N79-21217**	NOAA-TH-ERL-OCSEAP-1	22	p0344	N79-17374 *
NASA-TH-75442	21	p0195	N79-12547**	NOAA-78082203	21	p0222	N79-14581 *
NASA-TH-78186	21	p0173	N79-10519**	NOAA-78090601	21	p0226	N79-15207 *
NASA-TH-78196	21	p0173	N79-10524**	NOAA-78100601	22	p0331	N79-16180 *
NASA-TH-78199	21	p0172	N79-10514**	NOAA-78102401	22	p0356	N79-19563 *
NASA-TH-78203	21	p0214	N79-13915**	NOAA-78102601	22	p0344	N79-17374 *
NASA-TH-78206	21	p0196	N79-12556**	NOAA-78110701	22	p0344	N79-17366 *
NASA-TH-78212	21	p0226	N79-15247**	NOAA-78110702	22	p0344	N79-17367 *
NASA-TH-78218	22	p0342	N79-17338**	NOAA-78110703	22	p0344	N79-17368 *
NASA-TH-78219	22	p0371	N79-21618**				
NASA-TH-78222	22	p0360	N79-20495**	NP-23145	21	p0187	N79-11513 *
NASA-TH-78223	22	p0371	N79-21620**	NP-23292	21	p0211	N79-13543 *
NASA-TH-78324	21	p0195	N79-12542**	NRL-MR-3780	21	p0201	N79-13182 *
NASA-TH-78749	21	p0191	N79-11560**	NRL-MR-3844	22	p0357	N79-20272 *
NASA-TH-78912	21	p0204	N79-13472**				
NASA-TH-78993	22	p0345	N79-17859**	NSF/AER-76-08210	22	p0330	N79-16138 *
NASA-TH-78994	21	p0183	N79-11481**	NSF/RA-770517	21	p0230	N79-15422 *
NASA-TH-78995	21	p0183	N79-11479**	NSF/RA-770583	21	p0199	N79-12579 *
NASA-TH-78996	21	p0193	N79-11955**	NSF/RA-770592	22	p0335	N79-16380 *
NASA-TH-78997	22	p0333	N79-16355**	NSF/RA-770652	22	p0335	N79-16385 *
NASA-TH-78999	21	p0183	N79-11478**	NSF/RA-780018	21	p0222	N79-14586 *
NASA-TH-79007	21	p0183	N79-11477**	NSF/RA-780065	21	p0199	N79-12577 *
NASA-TH-79012	22	p0341	N79-17335**	NSF/RA-780088	21	p0214	N79-13913 *
NASA-TH-79018	22	p0342	N79-17336**	NSF/RA-780196	21	p0194	N79-12250 *
NASA-TH-79021	21	p0195	N79-12548**	NSF/RA-780267	22	p0343	N79-17349 *
NASA-TH-79023	21	p0226	N79-15267**	NSF/RA-780272	22	p0343	N79-17354 *
NASA-TH-79031	21	p0194	N79-12086**	NSF/RA-780302	22	p0367	N79-21530 *
NASA-TH-79032	22	p0341	N79-17333**	NSF/RANN/SE/AER73-03197/PB/78	21	p0198	N79-12572 *
NASA-TH-79034	22	p0333	N79-16357**	NSF/RANN/SE/AER73-03197/PB/77	22	p0343	N79-17349 *
NASA-TH-79035	22	p0338	N79-16930**				
NASA-TH-79037	21	p0229	N79-15403**	NSR-7-1	22	p0367	N79-21547**
NASA-TH-79044	22	p0337	N79-16721**	NSS-MR-RP-011	22	p0330	N79-16057**
NASA-TH-79083	21	p0229	N79-15410**	NTIS/PS-75/070	21	p0190	N79-11550 *
NASA-TH-79084	22	p0360	N79-20494**	NTIS/PS-75/089	21	p0231	N79-15436 *
NASA-TH-79086	22	p0330	N79-16136**	NTIS/PS-75/137	22	p0350	N79-18465 *
NASA-TH-79089	22	p0357	N79-20114**	NTIS/PS-75/214	21	p0176	N79-10552 *
NASA-TH-79097	21	p0229	N79-15411**	NTIS/PS-75/345	21	p0211	N79-13546 *
NASA-TH-79101	22	p0368	N79-21549**	NTIS/PS-75/346	21	p0212	N79-13557 *
NASA-TH-79116	22	p0357	N79-20118**	NTIS/PS-75/490	21	p0171	N79-10363 *
NASA-TH-79122	22	p0368	N79-21550**	NTIS/PS-75/628	21	p0212	N79-13555 *
NASA-TH-79130	22	p0360	N79-20498**	NTIS/PS-75/630	21	p0191	N79-11553 *
NASA-TH-79667	22	p0351	N79-18815**	NTIS/PS-75/689	21	p0211	N79-13546 *
NASA-TH-79719	22	p0345	N79-17897**	NTIS/PS-75/691	21	p0212	N79-13557 *
NASA-TH-79966	21	p0215	N79-13937**	NTIS/PS-75/692	22	p0350	N79-18465 *
NASA-TH-80001	21	p0224	N79-15113**	NTIS/PS-75/693	21	p0231	N79-15436 *
NASA-TH-80002	21	p0225	N79-15114**	NTIS/PS-75/743	21	p0190	N79-11550 *
NASA-TH-80013	21	p0225	N79-15125**	NTIS/PS-75/826	22	p0331	N79-16145 *
NASA-TH-80413	22	p0367	N79-21538**	NTIS/PS-76/0560	21	p0171	N79-10363 *
NASA-TP-1359	21	p0223	N79-14679**	NTIS/PS-76/0561	21	p0172	N79-10364 *
NASA-TP-1369	22	p0346	N79-18287**	NTIS/PS-76/0710	21	p0191	N79-11553 *
NASA-TP-1389	21	p0223	N79-14678**	NTIS/PS-76/0727	21	p0211	N79-13546 *
NASA-TP-1393	21	p0215	N79-14099**	NTIS/PS-76/0728	21	p0211	N79-13547 *
NATO/CCMS-74/1	21	p0190	N79-11549 *	NTIS/PS-76/0767	21	p0190	N79-11550 *
NATO/CCMS-74/2	21	p0191	N79-11558 *	NTIS/PS-76/0768	21	p0190	N79-11551 *
NATO/CCMS-75	21	p0206	N79-13508 *	NTIS/PS-76/0796	21	p0212	N79-13557 *
NATO/CCMS-83	22	p0363	N79-20525 *	NTIS/PS-76/0797	21	p0212	N79-13558 *
NATO/CCMS-84	22	p0372	N79-21631 *	NTIS/PS-76/0800	21	p0212	N79-13555 *
NATO/CCMS-85	22	p0275	N79-25926 *	NTIS/PS-76/0801	21	p0212	N79-13556 *
NBS-BSS-113	22	p0345	N79-17744 *	NTIS/PS-76/0855	22	p0350	N79-18465 *
NBS-BSS-114	22	p0335	N79-16384 *	NTIS/PS-76/0871	22	p0331	N79-16145 *
NBS-BSS-116	22	p0355	N79-19467 *	NTIS/PS-76/0929	21	p0231	N79-15436 *
NBS-BSS-117	22	p0372	N79-21632 *	NTIS/PS-76/0930	21	p0231	N79-15437 *
NBS-GCR-78-130	21	p0212	N79-13552 *	NTIS/PS-77/0458	21	p0176	N79-10553 *
NBS-GCR-78-141-1-VOL-1	22	p0365	N79-21235 *	NTIS/PS-77/0458	21	p0178	N79-10566 *
NBS-GCR-78-141-2-VOL-2	22	p0357	N79-20291 *	NTIS/PS-77/0459	21	p0176	N79-10554 *
NBS-SP-515	21	p0190	N79-11544 *	NTIS/PS-77/0506	21	p0176	N79-10552 *
NBSIR-76-1143	21	p0190	N79-11543 *	NTIS/PS-77/0635	21	p0171	N79-10363 *
NBSIR-78-1143A	21	p0190	N79-11543 *	NTIS/PS-77/0637	21	p0172	N79-10364 *
NBSIR-78-1305A-REV-1	21	p0198	N79-12571 *	NTIS/PS-77/0827	21	p0211	N79-13546 *
NBSIR-78-1468-1	21	p0190	N79-11549 *	NTIS/PS-77/0829	21	p0211	N79-13547 *
NBSIR-78-1468-2-VOL-2	21	p0191	N79-11558 *	NTIS/PS-77/0839	21	p0191	N79-11553 *
NBSIR-78-1472	21	p0212	N79-13553 *	NTIS/PS-77/0850	21	p0199	N79-12591 *
NBSIR-78-1494	22	p0364	N79-21167 *	NTIS/PS-77/0853	21	p0199	N79-12593 *
NBSIR-78-1513	22	p0343	N79-17352 *	NTIS/PS-77/0882	21	p0190	N79-11550 *

# REPORT/ACCESSION NUMBER INDEX

HTIS/PS-77/0883 ..... 21 p0190 N79-11551 #  
 HTIS/PS-77/0898 ..... 21 p0212 N79-13557 #  
 HTIS/PS-77/0900 ..... 21 p0212 N79-13558 #  
 HTIS/PS-77/0956 ..... 21 p0212 N79-13555 #  
 HTIS/PS-77/0958 ..... 21 p0212 N79-13556 #  
 HTIS/PS-77/0991 ..... 21 p0222 N79-14587 #  
 HTIS/PS-77/0992 ..... 21 p0222 N79-14588 #  
 HTIS/PS-77/1036 ..... 22 p0350 N79-18465 #  
 HTIS/PS-77/1051 ..... 21 p0231 N79-15436 #  
 HTIS/PS-77/1052 ..... 21 p0231 N79-15437 #  
 HTIS/PS-77/1158 ..... 22 p0331 N79-16145 #  
 HTIS/PS-77/1161 ..... 22 p0343 N79-17348 #  
 HTIS/PS-78/0054 ..... 22 p0365 N79-21223 #  
 HTIS/PS-78/0693/8 ..... 21 p0176 N79-10552 #  
 HTIS/PS-78/0830/6 ..... 21 p0179 N79-10951 #  
 HTIS/PS-78/0836/3 ..... 21 p0176 N79-10553 #  
 HTIS/PS-78/0837/1 ..... 21 p0176 N79-10554 #  
 HTIS/PS-78/0838/9 ..... 21 p0178 N79-10566 #  
 HTIS/PS-78/0880/5 ..... 21 p0212 N79-13551 #  
 HTIS/PS-78/0880/1 ..... 21 p0171 N79-10363 #  
 HTIS/PS-78/0881/9 ..... 21 p0172 N79-10364 #  
 HTIS/PS-78/0961/9 ..... 21 p0191 N79-11552 #  
 HTIS/PS-78/0962/7 ..... 21 p0191 N79-11553 #  
 HTIS/PS-78/0971/8 ..... 21 p0199 N79-12591 #  
 HTIS/PS-78/0973/4 ..... 21 p0199 N79-12593 #  
 HTIS/PS-78/0997/3 ..... 21 p0190 N79-11550 #  
 HTIS/PS-78/0998/1 ..... 21 p0190 N79-11551 #  
 HTIS/PS-78/1014/6 ..... 21 p0211 N79-13545 #  
 HTIS/PS-78/1015/3 ..... 21 p0211 N79-13546 #  
 HTIS/PS-78/1016/1 ..... 21 p0212 N79-13550 #  
 HTIS/PS-78/1017/9 ..... 21 p0211 N79-13547 #  
 HTIS/PS-78/1108/6 ..... 21 p0212 N79-13557 #  
 HTIS/PS-78/1109/4 ..... 21 p0212 N79-13558 #  
 HTIS/PS-78/1114/4 ..... 21 p0212 N79-13554 #  
 HTIS/PS-78/1115/1 ..... 21 p0212 N79-13555 #  
 HTIS/PS-78/1116/9 ..... 21 p0212 N79-13556 #  
 HTIS/PS-78/1156/5 ..... 21 p0222 N79-14587 #  
 HTIS/PS-78/1157/3 ..... 21 p0222 N79-14588 #  
 HTIS/PS-78/1213/4 ..... 21 p0231 N79-15436 #  
 HTIS/PS-78/1214/2 ..... 21 p0231 N79-15437 #  
 HTIS/PS-78/1261/3 ..... 22 p0331 N79-16144 #  
 HTIS/PS-78/1262/1 ..... 22 p0331 N79-16145 #  
 HTIS/PS-78/1268/6 ..... 22 p0343 N79-17348 #  
 HTIS/PS-78/1341/3 ..... 22 p0350 N79-18465 #  
 HTIS/PS-78/1342/1 ..... 22 p0350 N79-18466 #  
 HTIS/PS-79/0030/1 ..... 22 p0365 N79-21223 #  
  
 HTISUB/C/027-001 ..... 21 p0221 N79-14576 #  
  
 NUREG-CR-0066 ..... 21 p0217 N79-14344 #  
 NUREG-CR-0328 ..... 21 p0223 N79-14934 #  
  
 NUREG-0247 ..... 21 p0231 N79-15431 #  
 NUREG-0480 ..... 22 p0355 N79-19469 #  
  
 NVO/1531-2 ..... 22 p0366 N79-21523 #  
  
 ONERA, TP NO. 1978-107 ..... 21 p0036 A79-11572 #  
 ONERA, TP NO. 1978-137 ..... 21 p0155 A79-18560 #  
  
 OPAV-41-P4 ..... 21 p0197 N79-12560 #  
  
 OPPORTUNITY-BRIEF-11 ..... 21 p0226 N79-15207 #  
  
 ORAU-133 ..... 21 p0232 N79-15830 #  
  
 ORAU/IEA (M) -78-10 ..... 21 p0209 N79-13531 #  
 ORAU/IEA (R) -77-12 ..... 21 p0174 N79-10534 #  
  
 ORESU-W-78-001 ..... 22 p0356 N79-19563 #  
  
 ORNL-TR-4483 ..... 21 p0221 N79-14574 #  
  
 ORNL-5320 ..... 21 p0184 N79-11487 #  
 ORNL-5363 ..... 22 p0348 N79-18447 #  
 ORNL-5493 ..... 22 p0369 N79-21562 #  
  
 ORNL/EIS-147 ..... 22 p0372 N79-21640 #  
 ORNL/HUD/HIUS-32 ..... 21 p0220 N79-14564 #  
 ORNL/HUD/HIUS-33 ..... 21 p0221 N79-14575 #  
 ORNL/SUB-7117/25 ..... 21 p0193 N79-11889 #  
 ORNL/TH-5890-52 ..... 21 p0175 N79-10541 #  
 ORNL/TH-5890-53 ..... 21 p0175 N79-10542 #  
 ORNL/TH-5890/54 ..... 21 p0186 N79-11511 #  
 ORNL/TH-6069 ..... 21 p0192 N79-11570 #  
 ORNL/TH-6392 ..... 21 p0214 N79-13849 #  
  
 OTA-E-66-VOL-1 ..... 21 p0190 N79-11548 #  
 OTA-E-77-VOL-2 ..... 21 p0218 N79-14530 #

OTA-0-62 ..... 21 p0191 N79-11556 #  
 OTA-0-63 ..... 21 p0191 N79-11557 #  
  
 OWRT-A-081-ILL (1) ..... 22 p0349 N79-18463 #  
  
 OWRT-W-211 (6254) (1) ..... 21 p0211 N79-13549 #  
  
 PB-276469/4 ..... 21 p0171 N79-10240 #  
 PB-281189/1 ..... 21 p0178 N79-10574 #  
 PB-281271/7 ..... 21 p0178 N79-10591 #  
 PB-281649/4 ..... 21 p0177 N79-10562 #  
 PB-281815/1 ..... 21 p0189 N79-11542 #  
 PB-281817/7 ..... 21 p0177 N79-10560 #  
 PB-282494/4 ..... 21 p0177 N79-10564 #  
 PB-282531/3 ..... 21 p0171 N79-10241 #  
 PB-282546/1 ..... 21 p0178 N79-10604 #  
 PB-282652/7 ..... 21 p0176 N79-10555 #  
 PB-282653/5 ..... 21 p0176 N79-10556 #  
 PB-282654/3 ..... 21 p0177 N79-10557 #  
 PB-282655/0 ..... 21 p0177 N79-10558 #  
 PB-282656/8 ..... 21 p0177 N79-10559 #  
 PB-282787/1 ..... 21 p0177 N79-10565 #  
 PB-282923/2 ..... 21 p0181 N79-11447 #  
 PB-282924/0 ..... 21 p0181 N79-11446 #  
 PB-282928/1 ..... 21 p0177 N79-10561 #  
 PB-282929/9 ..... 21 p0177 N79-10563 #  
 PB-282940/6 ..... 21 p0179 N79-10968 #  
 PB-282949/7 ..... 21 p0171 N79-10243 #  
 PB-282983/6 ..... 21 p0178 N79-10610 #  
 PB-283028/9 ..... 21 p0178 N79-10595 #  
 PB-283066/9 ..... 21 p0190 N79-11546 #  
 PB-283076/8 ..... 21 p0179 N79-10679 #  
 PB-283103/0 ..... 21 p0191 N79-11557 #  
 PB-283104/8 ..... 21 p0191 N79-11556 #  
 PB-283170/9 ..... 21 p0191 N79-11555 #  
 PB-283171/7 ..... 21 p0191 N79-11554 #  
 PB-283237/6 ..... 21 p0190 N79-11543 #  
 PB-283428/1 ..... 21 p0190 N79-11549 #  
 PB-283429/9 ..... 21 p0191 N79-11558 #  
 PB-283477/8 ..... 21 p0190 N79-11544 #  
 PB-283657/5 ..... 21 p0178 N79-10603 #  
 PB-283677/3 ..... 21 p0199 N79-12576 #  
 PB-283706/0 ..... 21 p0190 N79-11547 #  
 PB-283721/9 ..... 21 p0198 N79-12571 #  
 PB-283733/4 ..... 21 p0198 N79-12575 #  
 PB-283770/6 ..... 21 p0190 N79-11548 #  
 PB-283787/0 ..... 21 p0198 N79-12573 #  
 PB-283796/1 ..... 21 p0198 N79-12574 #  
 PB-283973/6 ..... 21 p0199 N79-12601 #  
 PB-283998/3 ..... 21 p0198 N79-12572 #  
 PB-284041/1 ..... 21 p0195 N79-12424 #  
 PB-284045/2 ..... 21 p0200 N79-12606 #  
 PB-284081/7 ..... 21 p0200 N79-12602 #  
 PB-284480/1 ..... 21 p0211 N79-13548 #  
 PB-284658/2 ..... 21 p0194 N79-12251 #  
 PB-284691/3 ..... 21 p0222 N79-14583 #  
 PB-284697/0 ..... 21 p0199 N79-12578 #  
 PB-284703/6 ..... 21 p0199 N79-12579 #  
 PB-284741/6 ..... 21 p0214 N79-13913 #  
 PB-284742/4 ..... 21 p0194 N79-12250 #  
 PB-284743/2 ..... 21 p0217 N79-14521 #  
 PB-284823/2 ..... 21 p0199 N79-12577 #  
 PB-284855/4 ..... 21 p0201 N79-13152 #  
 PB-285129/3 ..... 21 p0211 N79-13549 #  
 PB-285196/2 ..... 21 p0213 N79-13590 #  
 PB-285227/5 ..... 21 p0213 N79-13592 #  
 PB-285260/6 ..... 21 p0212 N79-13552 #  
 PB-285360/4 ..... 21 p0212 N79-13553 #  
 PB-285381/0 ..... 21 p0217 N79-14397 #  
 PB-285420/6 ..... 21 p0223 N79-14635 #  
 PB-285440/4 ..... 21 p0213 N79-13591 #  
 PB-285713/4 ..... 21 p0222 N79-14582 #  
 PB-285797/7 ..... 21 p0224 N79-14946 #  
 PB-285864/5 ..... 21 p0223 N79-14618 #  
 PB-285880/1 ..... 21 p0216 N79-14243 #  
 PB-285910/6 ..... 21 p0230 N79-15428 #  
 PB-285937/9 ..... 21 p0232 N79-15864 #  
 PB-286002/1 ..... 21 p0222 N79-14586 #  
 PB-286074/0 ..... 21 p0226 N79-15304 #  
 PB-286075/7 ..... 21 p0226 N79-15305 #  
 PB-286076/5 ..... 21 p0227 N79-15306 #  
 PB-286077/3 ..... 21 p0227 N79-15307 #  
 PB-286078/1 ..... 21 p0231 N79-15430 #  
 PB-286135/9 ..... 21 p0231 N79-15432 #  
 PB-286172/2 ..... 21 p0223 N79-14641 #  
 PB-286208/4 ..... 21 p0232 N79-15474 #  
 PB-286222/5 ..... 21 p0230 N79-15425 #  
 PB-286231/6 ..... 21 p0223 N79-14643 #

# REPORT/ACCESSION NUMBER INDEX

PB-286246/4	21	p0230	N79-15423	#	PB-289967/2	22	p0372	N79-21630	#
PB-286294/4	21	p0227	N79-15308	#	PB-290126/2	22	p0372	N79-21626	#
PB-286295/1	21	p0227	N79-15309	#	PB-290160/1	22	p0364	N79-21167	#
PB-286296/9	21	p0227	N79-15310	#	PE-290162/7	22	p0373	N79-21670	#
PB-286297/7	21	p0227	N79-15311	#	PB-290173/4	22	p0367	N79-21530	#
PB-286298/5	21	p0227	N79-15312	#	PB-290237/7	22	p0373	N79-21671	#
PB-286299/3	21	p0227	N79-15313	#	PB-290345/8	22	p0356	N79-19563	#
PB-286300/9	21	p0228	N79-15314	#	PB-291330/9	22	p0373	N79-21679	#
PB-286301/7	21	p0228	N79-15315	#	PB-291369/7	22	p0373	N79-21682	#
PB-286329/8	21	p0230	N79-15421	#					
PB-286365/2	21	p0232	N79-15473	#	PNL-2004-8	22	p0369	N79-21557	#
PB-286385/0	21	p0226	N79-15177	#	PNL-2004-9	22	p0361	N79-20504	#
PB-286400/7	21	p0230	N79-15424	#	PNL-2410	21	p0210	N79-13539	#
PB-286487/4	21	p0230	N79-15422	#	PNL-2482	21	p0202	N79-13252	#
PB-286550/9	21	p0232	N79-15868	#	PNL-2518	21	p0203	N79-13322	#
PB-286647/3	21	p0228	N79-15379	#	PNL-2521	21	p0209	N79-13527	#
PB-286659/8	21	p0232	N79-15479	#	PNL-2531	22	p0361	N79-20506	#
PB-286671/3	21	p0222	N79-14581	#	PNL-2545	22	p0356	N79-19568	#
PB-286688/7	21	p0231	N79-15439	#	PNL-2581	21	p0210	N79-13541	#
PB-286688/5	21	p0217	N79-14344	#					
PB-286689/3	21	p0223	N79-14934	#	PR-5	21	p0230	N79-15422	#
PB-286870/1	21	p0231	N79-15438	#	PR-6	21	p0199	N79-12577	#
PB-286900/6	22	p0336	N79-16497	#					
PB-286901/4	22	p0331	N79-16148	#	PWA-5500-18	21	p0194	N79-12084*	#
PB-286903/0	22	p0331	N79-16150	#	PWA-5565-15	21	p0200	N79-13050*	#
PB-286904/8	22	p0355	N79-19468	#	PWA-5594-48	22	p0337	N79-16850*	#
PB-286909/7	22	p0335	N79-16384	#					
PB-286924/6	22	p0336	N79-16439	#	QPR-1	22	p0334	N79-16368*	#
PB-286940/2	21	p0231	N79-15440	#	QPR-2	21	p0170	N79-10178	#
PB-286982/4	22	p0336	N79-16446	#	QPR-2	21	p0221	N79-14577	#
PB-287071/5	22	p0336	N79-16437	#	QPR-4	21	p0219	N79-14540*	#
PB-287091/3	22	p0330	N79-16139	#	QPR-11	21	p0218	N79-14537*	#
PB-287115/0	22	p0335	N79-16385	#					
PB-287180/4	22	p0339	N79-17026	#	QR-1	21	p0221	N79-14576	#
PB-287306/5	21	p0231	N79-15431	#	QR-1	21	p0225	N79-15137*	#
PB-287314/9	22	p0335	N79-16380	#	QR-1	22	p0359	N79-20486*	#
PB-287361/0	22	p0335	N79-16382	#	QR-2	22	p0359	N79-20485*	#
PB-287363/6	22	p0339	N79-17309	#	QR-2	22	p0361	N79-20500	#
PB-287386/7	22	p0330	N79-16138	#	QR-3	22	p0334	N79-16366*	#
PB-287394/1	22	p0332	N79-16342	#	QR-3	22	p0354	N79-19459*	#
PB-287410/5	22	p0343	N79-17351	#	QR-4	21	p0219	N79-14555*	#
PB-287417/0	22	p0343	N79-17349	#	QR-4	22	p0358	N79-20480*	#
PB-287508/6	22	p0343	N79-17354	#	QR-5	22	p0357	N79-20281*	#
PB-287519/3	22	p0343	N79-17352	#	QR-5	22	p0359	N79-20484*	#
PB-287521/9	22	p0338	N79-17025	#	QR-7	22	p0355	N79-19462*	#
PB-287577/1	22	p0343	N79-17353	#	QR-10	22	p0333	N79-16365*	#
PB-287730/6	22	p0339	N79-17027	#					
PB-287772/8	22	p0343	N79-17350	#	QTPR-2	22	p0362	N79-20510	#
PB-287799/1	22	p0344	N79-17364	#	QTPR-13	21	p0219	N79-14541*	#
PB-287800/7	22	p0344	N79-17365	#					
PB-287804/9	22	p0345	N79-17744	#	R-247U	22	p0356	N79-20109	#
PB-287846/0	22	p0340	N79-17311	#	R-247U-VOL-1	22	p0351	N79-18969	#
PB-287868/4	21	p0226	N79-15207	#					
PB-287910/4	22	p0349	N79-18464	#	RAND/R-2212-ARPA	21	p0193	N79-11859	#
PB-287937/7	22	p0346	N79-18061	#					
PB-288046/6	22	p0349	N79-18463	#	REPT-14	21	p0226	N79-15304	#
PB-288128/2	22	p0349	N79-18462	#	REPT-30	21	p0187	N79-11513	#
PB-288211/6	22	p0350	N79-18497	#	REPT-33	21	p0211	N79-13543	#
PB-288223/1	22	p0344	N79-17378	#	REPT-78-2-FPH	21	p0217	N79-14397	#
PB-288313/0	22	p0351	N79-18834	#	REPT-79-243	22	p0347	N79-18373*	#
PB-288400/5	22	p0355	N79-19488	#	REPT-2258/8	22	p0348	N79-18451*	#
PB-288497/1	22	p0353	N79-19429	#	REPT-5102-107	22	p0359	N79-20491*	#
PB-288578/8	22	p0355	N79-19470	#	REPT-5103-47-VOL-1	22	p0368	N79-21548*	#
PB-288602/6	22	p0350	N79-18487	#	REPT-5104-26-VOL-1	22	p0360	N79-20492*	#
PB-288603/4	22	p0350	N79-18488	#					
PB-288604/2	22	p0350	N79-18489	#	RI/RD78-207	21	p0230	N79-15413	#
PB-288630/7	22	p0352	N79-19173	#					
PB-288656/2	22	p0331	N79-16140	#	RMP-5495-1	21	p0224	N79-14946	#
PB-288825/3	22	p0355	N79-19472	#					
PB-288874/1	22	p0356	N79-19496	#	RR-134	22	p0349	N79-18463	#
PB-288935/0	22	p0344	N79-17374	#					
PB-289154/7	22	p0344	N79-17366	#	RRC-78-R-607	21	p0183	N79-11473*	#
PB-289155/4	22	p0344	N79-17367	#					
PB-289156/2	22	p0344	N79-17368	#	R7901-1	22	p0337	N79-16892*	#
PB-289204/0	22	p0355	N79-19467	#					
PB-289244/6	22	p0363	N79-20526	#	SAE PAPER 780523	21	p0031	A79-10398*	#
PB-289380/8	22	p0363	N79-20525	#	SAE PAPER 781010	22	p0274	A79-25892	#
PB-289492/1	22	p0372	N79-21631	#	SAE PAPER 781026	22	p0274	A79-25899	#
PB-289493/9	22	p0372	N79-21625	#	SAE PAPER 781027	22	p0274	A79-25900	#
PB-289585/2	22	p0355	N79-19469	#	SAE PAPER 790013	22	p0314	A79-31352	#
PB-289729/6	22	p0363	N79-20524	#	SAE PAPER 790014	22	p0313	A79-31351	#
PB-289775/9	22	p0365	N79-21224	#	SAE PAPER 790107	22	p0314	A79-31355	#
PB-289817/9	22	p0364	N79-20727	#	SAE PAPER 790109	22	p0314	A79-31356*	#
PB-289823/7	22	p0365	N79-21235	#	SAE PAPER 790110	22	p0314	A79-31357	#
PB-289824/5	22	p0357	N79-20291	#	SAE PAPER 790111	22	p0314	A79-31358	#
PB-289837/7	22	p0372	N79-21628	#	SAE PAPER 790128	22	p0314	A79-31360	#
PB-289912/8	22	p0372	N79-21632	#	SAE PAPER 790129	22	p0314	A79-31361	#
PB-289921/9	22	p0373	N79-21661	#	SAE PAPER 790158	22	p0314	A79-31363	#
PB-289940/9	22	p0373	N79-21662	#	SAE PAPER 790161	22	p0315	A79-31366	#



# REPORT/ACCESSION NUMBER INDEX

SAE PAPER 790162 ..... 22 p0315 A79-31367  
 SAE PAPER 790327 ..... 22 p0315 A79-31368\*  
 SAE PAPER 790328 ..... 22 p0315 A79-31369  
 SAE PAPER 790329 ..... 22 p0315 A79-31370  
 SAE PAPER 790355 ..... 22 p0315 A79-31371  
 SAE PAPER 790436 ..... 22 p0315 A79-31374  
 SAE PAPER 790438 ..... 22 p0315 A79-31375  
 SAE PAPER 790439 ..... 22 p0316 A79-31376

SAN-W1364-01 ..... 21 p0195 N79-12256 #1

SAN/1109-77-7 ..... 21 p0210 N79-13542 #  
 SAN/1241-77/1 ..... 21 p0171 N79-10237 #  
 SAN/1326-1/2 ..... 21 p0174 N79-10532 #  
 SAN/1335-1 ..... 21 p0195 N79-12450 #  
 SAN/1587-2 ..... 21 p0211 N79-13544 #

SAND-76-0381 ..... 21 p0221 N79-14569 #  
 SAND-77-1173 ..... 21 p0221 N79-14568 #  
 SAND-77-1241 ..... 21 p0221 N79-14567 #  
 SAND-77-1403 ..... 21 p0220 N79-14566 #  
 SAND-77-1528 ..... 21 p0197 N79-12565 #  
 SAND-77-8035 ..... 21 p0221 N79-14571 #  
 SAND-77-8299 ..... 21 p0172 N79-10435 #  
 SAND-78-0016C ..... 21 p0175 N79-10539 #  
 SAND-78-0049 ..... 21 p0210 N79-13537 #  
 SAND-78-0308-REV ..... 21 p0187 N79-11525 #  
 SAND-78-0641 ..... 21 p0209 N79-13532 #  
 SAND-78-0700 ..... 21 p0185 N79-11496 #  
 SAND-78-0815 ..... 21 p0208 N79-13522 #  
 SAND-78-0880C ..... 21 p0187 N79-11516 #  
 SAND-78-0917C ..... 21 p0188 N79-11527 #  
 SAND-78-0948C ..... 21 p0176 N79-10550 #  
 SAND-78-1000C ..... 21 p0187 N79-11517 #  
 SAND-78-1156C ..... 21 p0188 N79-11529 #  
 SAND-78-1191C ..... 21 p0198 N79-12570 #  
 SAND-78-7018 ..... 21 p0187 N79-11521 #  
 SAND-78-7021 ..... 21 p0206 N79-13509 #  
 SAND-78-8056 ..... 21 p0221 N79-14570 #  
 SAND-78-8672 ..... 21 p0189 N79-11537 #

SD-78-AD-0075 ..... 21 p0225 N79-15137\*#  
 SD-78-AP-0023-1-VOL-1 ..... 22 p0329 N79-16036\*#  
 SD-78-AP-0023-2-VOL-2 ..... 22 p0330 N79-16037\*#  
 SD-78-AP-0023-3-VOL-3 ..... 21 p0225 N79-15138\*#  
 SD-78-AP-0023-5-VOL-5 ..... 21 p0225 N79-15139\*#  
 SD-78-AP-0023-6-VOL-6 ..... 21 p0225 N79-15140\*#  
 SD-78-AP-0023-7-VOL-7 ..... 21 p0225 N79-15141\*#  
 SD-78-AP-0023-7-VOL-7-APP ..... 21 p0225 N79-15142\*#  
 SD-78-AP-0115 ..... 21 p0183 N79-11475\*#

SE-655 ..... 22 p0358 N79-20482\*#

SOA-76-328 ..... 21 p0181 N79-11454 #

SORI-EAS-78-347-3344P ..... 21 p0199 N79-12601 #

SQUID-FU-E2-78 ..... 22 p0338 N79-17011 #

SSD-79-0076 ..... 22 p0352 N79-19071\*#

SX/115/PL ..... 21 p0219 N79-14548\*#  
 SX/115/3Q ..... 22 p0354 N79-19459\*#

TETRAT-A-6053-02-78-368 ..... 21 p0197 N79-12560 #

TH-78-E-79 ..... 22 p0350 N79-18758 #

TID-3361 ..... 21 p0184 N79-11491 #  
 TID-4579-R10 ..... 21 p0197 N79-12566 #  
 TID-4583-R1 ..... 21 p0184 N79-11488 #  
 TID-27754 ..... 21 p0174 N79-10533 #  
 TID-27951 ..... 21 p0209 N79-13533 #  
 TID-28152-APP ..... 21 p0187 N79-11512 #  
 TID-28202 ..... 21 p0186 N79-11510 #  
 TID-28408 ..... 22 p0352 N79-19171 #  
 TID-28519 ..... 22 p0365 N79-21309 #

TH/EN/79-06 ..... 22 p0362 N79-20509 #

TH-152 ..... 21 p0192 N79-11613 #  
 TH-1978-4 ..... 21 p0226 N79-15145 #

TPR-59 ..... 22 p0371 N79-21622\*#

TR-1 ..... 21 p0184 N79-11483 #  
 TR-7802-0977 ..... 21 p0194 N79-12130\*#

TBB/TRR-648 ..... 21 p0232 N79-15868 #

TRE-1312 ..... 22 p0362 N79-20508 #

TRS-101 ..... 22 p0360 N79-20497\*#

TSC-USCG-77-4 ..... 22 p0366 N79-21406 #  
 TSC-USCG-78-1 ..... 21 p0203 N79-13375 #  
 TSC-USCG-78-12 ..... 22 p0338 N79-17019 #

UC-60 ..... 22 p0356 N79-19568 #

UCID-4033 ..... 21 p0204 N79-13480 #

UCRL-52000-78-6 ..... 21 p0215 N79-14168 #  
 UCRL-52349 ..... 21 p0195 N79-12439 #  
 UCRL-52385 ..... 21 p0185 N79-11497 #  
 UCRL-52589 ..... 22 p0342 N79-17337 #  
 UCRL-80113 ..... 21 p0217 N79-14377 #  
 UCRL-80116-PT-A ..... 21 p0215 N79-14165 #  
 UCRL-80451 ..... 21 p0181 N79-11412 #  
 UCRL-81159 ..... 21 p0189 N79-11536 #  
 UCRL-81178 ..... 21 p0189 N79-11538 #

UDRI-TR-78-41 ..... 21 p0196 N79-12559 #

UHNET-77-01 ..... 22 p0335 N79-16382 #

UII-70101 ..... 21 p0197 N79-12562 #

UIIU-WRC-78-0134 ..... 22 p0349 N79-18463 #

UMD-4908-13 ..... 22 p0363 N79-20525 #

UNTA-CA-06-0106-77-1-VOL-1 ..... 21 p0176 N79-10555 #  
 UNTA-CA-06-0106-77-2-VOL-2 ..... 21 p0176 N79-10556 #  
 UNTA-CA-06-0106-77-3-VOL-3 ..... 21 p0177 N79-10557 #  
 UNTA-CA-06-0106-77-4-VOL-4 ..... 21 p0177 N79-10558 #  
 UNTA-CA-06-0106-77-5-VOL-5 ..... 21 p0177 N79-10559 #

UNTA-NY-06-0062-77-1 ..... 21 p0177 N79-10563 #

US-PATENT-APPL-SN-017884 ..... 22 p0348 N79-18445\*#  
 US-PATENT-APPL-SN-027559 ..... 22 p0362 N79-20513\*#  
 US-PATENT-APPL-SN-112999 ..... 22 p0352 N79-19186\*#  
 US-PATENT-APPL-SN-286824 ..... 22 p0353 N79-19447\*#  
 US-PATENT-APPL-SN-598969 ..... 21 p0217 N79-14529\*#  
 US-PATENT-APPL-SN-632111 ..... 21 p0172 N79-10422\*#  
 US-PATENT-APPL-SN-730468 ..... 21 p0179 N79-11152\*#  
 US-PATENT-APPL-SN-760771 ..... 21 p0217 N79-14528\*#  
 US-PATENT-APPL-SN-762363 ..... 21 p0217 N79-14529\*#  
 US-PATENT-APPL-SN-765138 ..... 21 p0172 N79-10513\*#  
 US-PATENT-APPL-SN-765139 ..... 21 p0182 N79-11471\*#  
 US-PATENT-APPL-SN-770869 ..... 21 p0182 N79-11472\*#  
 US-PATENT-APPL-SN-801452 ..... 21 p0182 N79-11471\*#  
 US-PATENT-APPL-SN-803823 ..... 21 p0182 N79-11467\*#  
 US-PATENT-APPL-SN-824024 ..... 22 p0348 N79-18443\*#  
 US-PATENT-APPL-SN-829390 ..... 21 p0182 N79-11469\*#  
 US-PATENT-APPL-SN-838336 ..... 21 p0182 N79-11470\*#  
 US-PATENT-APPL-SN-844346 ..... 21 p0182 N79-11472\*#  
 US-PATENT-APPL-SN-891370 ..... 22 p0357 N79-20179\*#  
 US-PATENT-APPL-SN-899123 ..... 21 p0217 N79-14528\*#  
 US-PATENT-APPL-SN-903019 ..... 22 p0356 N79-19521\*#  
 US-PATENT-APPL-SN-906297 ..... 21 p0217 N79-14529\*#

US-PATENT-CLASS-15-230.16 ..... 21 p0172 N79-10422\*#  
 US-PATENT-CLASS-15-230.17 ..... 21 p0172 N79-10422\*#  
 US-PATENT-CLASS-29-125 ..... 21 p0172 N79-10422\*#  
 US-PATENT-CLASS-29-572 ..... 21 p0182 N79-11472\*#  
 US-PATENT-CLASS-44-51 ..... 21 p0179 N79-11152\*#  
 US-PATENT-CLASS-60-508 ..... 22 p0348 N79-18443\*#  
 US-PATENT-CLASS-60-572 ..... 22 p0348 N79-18443\*#  
 US-PATENT-CLASS-60-641 ..... 22 p0348 N79-18443\*#  
 US-PATENT-CLASS-74-572 ..... 21 p0172 N79-10422\*#  
 US-PATENT-CLASS-117-35 ..... 22 p0352 N79-19186\*#  
 US-PATENT-CLASS-126-270 ..... 21 p0182 N79-11471\*#  
 US-PATENT-CLASS-126-271 ..... 21 p0182 N79-11471\*#  
 US-PATENT-CLASS-126-271 ..... 21 p0217 N79-14529\*#  
 US-PATENT-CLASS-126-271 ..... 22 p0348 N79-18443\*#  
 US-PATENT-CLASS-136-89CC ..... 21 p0182 N79-11467\*#  
 US-PATENT-CLASS-136-89SJ ..... 21 p0182 N79-11467\*#  
 US-PATENT-CLASS-136-89SJ ..... 21 p0217 N79-14528\*#  
 US-PATENT-CLASS-165-105 ..... 22 p0348 N79-18443\*#  
 US-PATENT-CLASS-204-32 ..... 21 p0182 N79-11469\*#  
 US-PATENT-CLASS-204-33 ..... 21 p0182 N79-11469\*#  
 US-PATENT-CLASS-204-37R ..... 21 p0182 N79-11469\*#  
 US-PATENT-CLASS-204-38B ..... 21 p0182 N79-11469\*#  
 US-PATENT-CLASS-204-157.1R ..... 21 p0182 N79-11470\*#  
 US-PATENT-CLASS-208-8 ..... 21 p0179 N79-11152\*#  
 US-PATENT-CLASS-208-10 ..... 21 p0179 N79-11152\*#

## REPORT/ACCESSION NUMBER INDEX

US-PATENT-CLASS-250-527	21	p0182	N79-11470*
US-PATENT-CLASS-269-153	22	p0353	N79-19447*
US-PATENT-CLASS-302-66	21	p0179	N79-11152*
US-PATENT-CLASS-323-15	22	p0357	N79-20179*
US-PATENT-CLASS-323-20	22	p0357	N79-20179*
US-PATENT-CLASS-350-288	21	p0182	N79-11471*
US-PATENT-CLASS-350-292	21	p0217	N79-14529*
US-PATENT-CLASS-350-293	21	p0217	N79-14529*
US-PATENT-CLASS-350-299	21	p0182	N79-11471*
US-PATENT-CLASS-350-320	21	p0217	N79-14529*
US-PATENT-CLASS-357-15	21	p0182	N79-11467*
US-PATENT-CLASS-357-16	21	p0182	N79-11467*
US-PATENT-CLASS-357-30	21	p0182	N79-11467*
US-PATENT-CLASS-357-30	21	p0217	N79-14528*
US-PATENT-CLASS-357-65	21	p0182	N79-11467*
US-PATENT-CLASS-357-67	21	p0182	N79-11467*
US-PATENT-CLASS-427-75	21	p0182	N79-11472*
US-PATENT-CLASS-427-84	21	p0182	N79-11472*
US-PATENT-CLASS-427-123	21	p0182	N79-11472*
US-PATENT-CLASS-427-126	21	p0182	N79-11472*
US-PATENT-CLASS-427-261	21	p0182	N79-11472*
US-PATENT-CLASS-427-343	21	p0182	N79-11472*
US-PATENT-CLASS-427-398A	21	p0182	N79-11472*
US-PATENT-CLASS-427-399	21	p0182	N79-11472*
US-PATENT-CLASS-428-133	21	p0172	N79-10422*
US-PATENT-CLASS-429-13	21	p0172	N79-10513*
US-PATENT-CLASS-429-41	21	p0172	N79-10513*
US-PATENT-CLASS-429-42	21	p0172	N79-10513*
US-PATENT-3,173,801	22	p0352	N79-19186*
US-PATENT-3,262,694	22	p0353	N79-19447*
US-PATENT-4,065,053	21	p0217	N79-14529*
US-PATENT-4,082,569	21	p0182	N79-11472*
US-PATENT-4,091,798	21	p0182	N79-11471*
US-PATENT-4,098,142	21	p0172	N79-10422*
US-PATENT-4,100,331	21	p0172	N79-10513*
US-PATENT-4,104,084	21	p0182	N79-11467*
US-PATENT-4,104,134	21	p0182	N79-11469*
US-PATENT-4,105,517	21	p0182	N79-11470*
US-PATENT-4,121,995	21	p0179	N79-11152*
US-PATENT-4,122,214	21	p0182	N79-11472*
US-PATENT-4,122,833	21	p0182	N79-11471*
US-PATENT-4,131,336	21	p0217	N79-14529*
US-PATENT-4,131,486	21	p0217	N79-14528*
US-PATENT-4,135,367	22	p0348	N79-18443*
US-PATENT-4,143,314	22	p0357	N79-20179*
USAFESA-RT-2052	22	p0371	N79-21624 *
USCG-D-10-78	21	p0203	N79-13375 *
USCG-D-12-78	22	p0338	N79-17019 *
USCG-D-13-78	22	p0366	N79-21406 *
USCSG-AS-01-78	22	p0331	N79-16140 *
UWEL-P-78/005	21	p0231	N79-15432 *
VKI-LS-100-VOL-1	22	p0331	N79-16260 *
VPI-SU-5648-1	21	p0204	N79-13478 *
WFPS-THE-071	21	p0193	N79-11889 *
WMO-467	21	p0192	N79-11613 *
WYLE-TR-531-25	21	p0173	N79-10521**
WYLE-TR-531-26	21	p0172	N79-10515**
W78-10288	21	p0211	N79-13549 *
W78-11211	21	p0231	N79-15432 *
W79-00007	22	p0343	N79-17353 *
W79-00453	22	p0349	N79-18463 *
Y/SUB-77/14261	21	p0209	N79-13528 *

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